1999 Imported Fire Ant Conference

The Sheraton Charleston Hotel
Charleston, South Carolina
March 3-5, 1999

Hosted by
Clemson University Department of Entomology
and The Berkeley County Extension Office
South Carolina

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Charleston, SC 29403
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A special Thanks to the following industry and Cooperative Extension Colleagues who acted as moderators and hosts at the conference:

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Carlin Munnerlyn, Georgetown Co.
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Kathryn White, Greenwood Co.

Proceedings of The 1999 Imported Fire Ant Conference

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(NS = Not Submitted)

Poster Presentations

The Texas Imported Fire Ant Research & Management Plan - Project Highlights for 1998 and Community-Wide Imported Fire Ant Management Projects at Mt. Pleasant, San Antonio, Austin, Houston and Dallas

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The red imported fire ant, Solenopsis *invicta* Buren, infests the eastern two-thirds of Texas, as well as all of the southeastern United States. In 1998, these ants were found in California. In Texas, they cause approximately $300 million in losses per year, including a $67 million annual loss in the cattle production system alone. Aside from medical consequences of fire ant stings (about 1 percent of the population is hypersensitive to stings), the ants disable electrical equipment and affect wildlife. The presence of the multiple queen form of the ant is thought to be increasing ant populations, thereby increasing the damage they do.

There are more than 3 million households in Dallas/Fort Worth, Austin, Houston, and San Antonio. People in 85 percent of these households spend about $36 annually on fire ant control, medical costs and other damage caused by the ants — totaling $93 million per year.

Currently, fire ants are controlled largely by insecticides. Overuse and misuse of ant mound treatments, particularly with diazinon products, is blamed for contamination of surface runoff water in several Texas cities, including Fort Worth.

In 1997, Texas A&M scientists and extension personnel teamed up with other Texas agencies and universities to create a statewide fire ant research and management plan to control, not eradicate, the pests. In the first year of the plan, much has been accomplished. Extension IPM agents have been placed in Dallas/Fort Worth, Austin, Houston, and San Antonio to educate the public at large about ways to manage fire ants and to work with neighborhoods to implement community-wide management programs to treat for fire ants at the same time. One community from each city has been selected as a pilot program to measure the effectiveness of community-wide management programs. In September 1998, the group created a state-proclaimed Fire Ant Awareness Week to educate the public about research progress being made and about another new approach — broadcasting non-toxic, slow-acting baits in the fall that will kill ants during the winter while people are indoors. To get this new approach across to the public, a communications campaign with the theme, "Tackle fire ants in the fall," was implemented. A news conference kicked off the campaign, which included a cartoon TV PSA and radio PSA that aired in all major media markets, billboards in the major cities, newspaper and cable TV ads, Web site, print and broadcast news releases, and packets for county agents that included fill-in-the-blank news releases and columns.

As a result of the campaign, page accesses to the Web site increased from 2,000 a month to 100,000 a month and stores sold out of bait. One neighborhood's residents have coordinated fire ant management for the past three years and report that they don't have a fire ant problem any longer. Evaluation in terms of ant reduction in monitored areas will take place in 1999.

Fire Ant Management Pilot Showcase Programs Underway Across Texas

Mt. Pleasant. A "showcase" program was established at the HUD Housing Authority in Mt. Pleasant (NE Texas) during Fire Ant Awareness Week, September 14 through 20, 1998. A press conference was held the day of treatment (Sept. 17) at which Rep. Tom Ramsay, legislative sponsor of the Fire Ant Plan, and others addressed a crowd of over 60 people, including several County Extension Agents and out-of-town residents. Several other HUD facilities have subsequently contacted us for information and programs.

In addition, community-wide fire ant management programs and result demonstrations have received assistance to become established with local County Agents in Franklin Co. (Mt. Vernon), and Marion Co. (Jefferson). In cooperation with the County Agent of Bowie Co. (Texarkana) and a County Commissioner-elect, a county-specific fire ant management program was developed and adopted by their Commissioner's Court.

San Antonio. The Oxbow Neighborhood Association in San Antonio learned about community-wide fire ant programs in a February '98 presentation and decided to take action. Almost 50 percent, or 495 out 1000 homes participated in the program. The Oxbow group planned to purchase PT-370 Ascend® Fire Ant Bait, but the San Antonio Pest Control Association donated the bait at the last minute. Volunteers from the San Antonio Pest Control Association and the Green Brigade Program assisted the Oxbow group by broadcasting bait over common areas, parks and homes in the neighborhood. The Green Brigade Program is an Extension Service program designed to involve first-offender teens in city landscape and gardening projects as a way to "work off" restitution for their crimes.

Soon after the Oxbow Fire Ant Day, the Northchase Homeowner Association also decided to hold a neighborhood Fire Ant Day after an Extension Service presentation. In a show of neighborhood solidarity, the Oxbow neighborhood group donated 25 pounds of bait they had left over to the Northchase group for their program. The Northchase group had 49 of 114 homes participate. Northchase Homeowner Association president, Richard Meneses, said, "The neighborhood has never participated in something with as much enthusiasm and involvement as this Fire Ant Day".

The Encino Park Homeowner Association requested a neighborhood do-it-yourself "kit" to help establish their community-wide fire ant management program. They scheduled their Fire Ant Day in late August, but tropical storm Charley rained on their parade! They reportedly postponed their attack on fire ants for a week and had good participation at that time.

The Jade Oaks Homeowner Association, in northwest San Antonio, was so excited about beginning a community fire ant program that they called the Bexar County Extension office and asked for guidance about starting their program. The real estate office for Jade Oaks promotes their newly initiated community fire ant program as a selling point for prospective home buyers!

Jade Oaks agreed to be the showcase pilot program in Bexar County for 1998-1999. A biological survey in 15 of 91 front lawns revealed imported fire ants in every lawn with three other species of ants present in much fewer numbers. Bret Royal, Developmental Representative with American Cyanamid donated Amdro® Insecticide Bait to treat common areas and vacant lots, and promotional "Block Party" materials .

Interest and involvement was high, with 81 of 91 homeowners participating. The association members will receive a comprehensive survey requesting information on past history, insecticide use, and other impacts imported fire ants have had before and after program initiation.

Houston. The community of Belleau Woods Community Park in Humble organized a group of volunteers to treat their 7-acre community park on Sept. 22, 1998. Prior to the treatment, ant mound numbers were estimated and baited vials were used to monitor ant species present. Before treatment, the park harbored about 270 imported fire ant mounds per acre. No other ant species were collected. The community had their annual picnic at the park in late October and no one was stung by a fire ant! Post-treatment ant surveys will be conducted to document the control of fire ants in this park.

An educational program for the North Houston Heights community in August resulted in plans for a community-wide fire ant management program initiated on October 3. Prior to the treatment, ant mound numbers were estimated and ant species were monitored using baited vials. Twelve lots were randomly selected to monitor ants. Each lot had from 1 to 20 ant mounds. Red imported fire ants were present in every lot, and only two other ant species were detected. Volunteers from the homeowners association and the Extension Service treated over 90 percent of the lots in about three hours. Ant population levels will be monitored periodically to document the effectiveness of the treatment.

The Copperbrook Homeowners Association has initiated their own community-wide fire ant management project. They have had two fire ant days this year, with homeowners treating the ants with whatever they had on hand. A neighborhood "kit" was mailed to them earlier this year with information. Next spring, an educational program will be given and the Two-Step Method for fire ant control will be implemented in this community.

Austin. Sun City– Georgetown, a retirement community consisting of approximately 3,000 residents battle fire ants by having their Landscape Director and Golf Course Superintendent announce when their areas will be treated. During these designated "Fire Ant Weeks" residents are encouraged to treat their lawns for fire ants using a bait product. In the spring, the Extension Service presented a program on the benefits of community-wide fire ant management and provided publications and handouts. This fall, news articles were released stressing the importance of fall treatment to produce fewer fire ants by next spring. An educational presentation was also made at their Garden Club's meeting.

Following an initial contact through a survey, the City of Lago Vista contacted the Extension Service about the concept of doing a *city-wide* fire ant management program. The Extension Service initially gave a brief presentation to the city council at the request of the mayor. As a result, they designated a 'fire ant weekend' and posted announcements in the local newspaper several weeks ahead using material supplied by the Extension Service. It was encouraged that all residents purchase Amdro® and broadcast on that weekend. The progress of this program is being monitored.

During "Fire Ant Awareness Week" a pro-active citizen of Mountain City, Texas (a residential subdivision south of Austin in Hays Co.) contacted the Extension Service about doing a fire ant management program. The city council passed a resolution calling for homeowners and landowners to participate in a city-wide effort to combat fire ants by purchasing Amdro® fire ant bait and broadcasting it on Saturday, Oct. 3rd. A Hays High School Booster Club bought hand spreaders and Amdro® for use as a fund raiser and convenience to the residents.

Coupled with product donations, reduced purchase costs from Lowe's and Wal-Mart and rebate coupons furnished by Bret Royal, Development Rep. for American Cyanamid, participation was above average.

The Extension Service provided fact sheets, handouts and method demonstrations to residents who were not familiar with broadcasting a bait. A television crew taped the event and propagated added publicity. They are planning a spring 'fire ant day' that promises to be bigger and better.

A Board of Directors Member of the Mt. Bonnell Shores/Colorado Crossing Homeowner Association contacted the Extension Service following an informational letter sent out regarding fire ant management. She was interested in the community-wide management program, but needed additional information regarding native ants. A meeting was arranged to meet with her and the Extension Agent, to determine types of management, areas, and compliance issues. The Association is very organized and every homeowner is required to be a member. The neighborhood is comprised of 131 homeowners and is divided into five 'neighborhood watch' groups. Each group has a block captain, which makes distribution of information and communication easy. The block captains are Board members and utilizing the Extension Services' fire ant management program had previously been discussed.

Mt. Bonnell Shores Homeowner Association has been designated as a as the pilot showcase program for Travis County. Fire ant mound numbers were estimated in early October from random-selected yards, followed by obtaining ant samples using baited vials to determine infestation and ant species present. Flyers were sent out and distributed to each homeowner explaining the program and a date set for treatment. Since the Extension Service is using the neighborhood as an enhanced Result Demonstration, baits were donated for use as test trials in each block. Block captains distributed enough bait to each participant to treat their property. Volunteers treated yards that owners were not able to treat. Survey questionnaires were also passed out to each participant.

Of the 134 lots possible (not counting untreated "control" lots), 119 were treated for a participation rate of 88.8 percent. Charts have been developed to show ant distribution by species, lots treated, and an aerial photo will allow digitization of data.

Dallas and Fort Worth. The State Fair of Texas was a big event for the Dallas/Fort Worth metroplex. More than 52 volunteers were trained in fire ant biology and management options. Volunteers were also given an overview of the Texas Imported Fire Ant Research and Management Plan. These individuals manned the fire ant booth and display at the State Fair from September 25 through October 18, 1998. They answered questions about fire control, the ant's origins, ongoing research and politics (to the best of their abilities). Over 7,600 handouts and publications were given to booth visitors.

During the day on October 9, the Texas Department of Agriculture hosted "Fire Ant Day" in the Food and Fiber Pavilion. On this day the Extension Service made presentations about fire control, involving adults and children, and using questions to interact with the audiences. Feedback from the volunteers has been positive and participation in the state fair will be a regular event.

During "Fire Ant Awareness Week", an appearance was made on the FOX- 4 "Insights" program. This interview launched the weeks activities in Dallas and Tarrant Counties and generated an increased volume of telephone calls requesting community-wide management kits and presentations. Fort Worth Community Cable aired a pre-recorded program in which Extension staff discussed fire ant biology and control. The City of Duncanville sponsored a community meeting during fire ant awareness week. This community meeting has resulted in the production of a Community-Wide Fire Ant Management video by the Duncanville Community Cable in cooperation with Extension Agent.

Result demonstrations have been established in Tarrant County, including one at the Northeast sub-courthouse and another in a pasture to reduce fire ant populations while preserving native red harvester ants.

Since March 1998, 26 community-wide fire ant management presentations have been made to neighborhood associations, crime watch units and civic clubs. The Singing Hills/Hidden Valley Neighborhood Association is working with the Texas Agricultural Extension Service and the City of Dallas Parks and Recreation Department to implement a community-wide project next spring. This group will likely serve as a showcase pilot project in Dallas county.

Acknowledgements

The authors wish to thank Lynette James, Agricultural Communications Specialist, and Anna Kjolen, Staff Assistant for the Texas Fire Ant Project, for their contributions and technical support for developing this proceedings article and the presentation.

Tennessee Mating Flight Study: Can the Biology of the Imported Fire Ant Be Used to Aid in Certification of Field Grown Nursery Stock?

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INTRODUCTION:

Practical and cost-effective quarantine treatments for certification of field grown/balled and burlapped (B&B) nursery stock are not currently available. Growers wanting to ship their nursery stock outside the IFA quarantined area have several treatment options available, but none are user-friendly or practical. Treatment options that are currently listed in 7CFR §301.81 include the following:

1. Total immersion (dipping) the root ball in a chlorpyrifos solution
2. Twice daily irrigation of root balls for three consecutive days with a chlorpyrifos solution
3. In-field treatments with a combination of bait plus granular chlorpyrifos

Total immersion of the root balls in insecticidal solutions disrupts the root ball, is logistically unfeasible, and causes worker exposure problems. Other options such as twice daily irrigation of root balls with insecticidal solutions causes problems with run-off and is highly labor intensive. Research into development of practical and cost-effective treatments is a high priority with the American Nursery & Landscape Association, Tennessee Nurserymen's Association, and the Southern Nurserymen's Association.

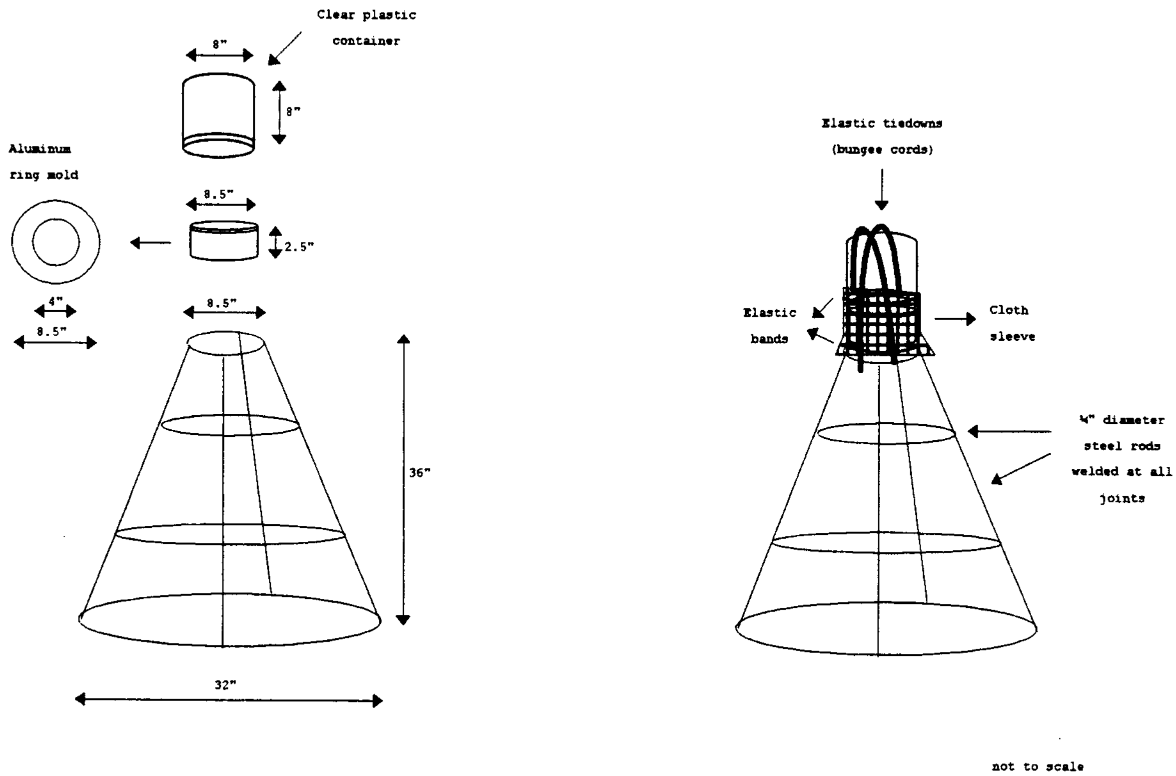
Since imported fire ant (IFA) mating flights occur year-round in most of the infested area, we have historically relied entirely upon contact action insecticides to certify movement of nursery stock outside the quarantine area. However, it seems likely that as the IFA extends its range to more northerly areas, differences in the biology of the ant may begin to occur.

Mating flight cages will be used in a pilot study in Tennessee to determine if a window of opportunity exists in which we can use the biology of the pest in combination with easily applied and highly efficacious baits to certify movement of nursery stock, specifically field grown nursery stock. The Tennessee pilot study was recently initiated in cooperation with ARS, CMAVE (Drs. Rick Brenner, David Oi and David Williams) PPQ, Tennessee Department Agriculture (Randy Dodd, Frank Heery and Rick Joyce), and Tennessee State University (Dr. Catharine Mannion). Flight cages were deployed at three sites (East, Central, and Western Tennessee), and will be monitored to determine mating flight patterns. This study is designed to last two or more years, and will be used to correlate weather with emergence, and thereby, use satellite information to develop probability contour maps showing the likelihood of alate emergence at any part of the infested area.

MATERIALS AND METHODS:

Flight traps were supplied by USDA, ARS, CMAVE in Gainesville, FL to the Gulfport Plant Protection Station (GPPS). GPPS repaired and slightly modified traps for use in clay soils of Tennessee. The cages are conical in shape with the frames made of ¼" diameter steel rods (Fig. 1). Fiberglass window screen was inserted in the frame and secured in place with 50 lb. test monofilament fishing line. The cages were placed over active IFA mounds and held in place with 8" aluminum tent pegs. An elastic cotton cloth sleeve (8" diameter) was placed over the top of the cage and the bottom of the sleeve held in place with an elastic band or bungee cord. An aluminum ring mold (cake pan) was placed on top of the cage and filled ca. ½ full with preservative (1:1 mixture of antifreeze and 70% alcohol). A plastic dome covered the ring mold. The cloth sleeve was pulled up over the ring pan onto the plastic dome and held in place with another elastic band. Elastic tiedowns (bungee cords) were criss-crossed over the dome, securing the entire catching apparatus to the wire cage.

Figure 1. Construction of Flight Cages.



Flight traps were placed over 8 mounds in three locations in Tennessee the week of September 8, 1997; Ooltewah (Hamilton Co.), Pulaski (Giles Co.) and La Grange (Fayette Co.), TN. Every two weeks, cooperators count and record the number of male and female alates caught in the preservative in the ring mold of each trap. Alates are discarded after counting. If a mound has moved the trap is also moved. Recorded data is transmitted to the Gulfport Plant Protection Station and ARS, CMAVE.

The Gulfport Plant Protection Station coordinates with collectors, assists in maintenance of traps and transmits collected data to ARS, CMAVE. ARS, CMAVE will correlate flight trap data with satellite information.

RESULTS:

East Tennessee (Ooltewah):

Both male and female alates were captured at the eastern Tennessee site in Ooltewah between September 9 (when the traps were set up) and October 13, 1997. No alates were captured between October 13, 1997 and March 13, 1998 when 2 males were captured in one trap. In 1998, major alate production in this area began in mid June and continued through the end of July. There was a small production of alates in September and October. Data is current through October 22, 1998.

Central Tennessee (Pulaski):

Only males were captured at the central Tennessee site in Pulaski between September 9 and October 13, 1997; one male was captured between October 13 and October 28, 1997. No alates were captured between November 28, 1997 and February 10, 1998 when 2 males were captured in two traps. In 1998, there was one surge of alate production in this area between March 27 and April 13, with the major production beginning in late May and continuing through the end of July. However, a reduced rate of alate production continued through November 11, 1998. Data is current through December 7, 1998, at which time no alates were captured.

West Tennessee (La Grange):

Both male and female alates were captured at the western site in La Grange between September 10 and September 29, 1997. Between late September and October 17, only females were captured. No alates were captured between late October, 1997 and mid May, 1998. In 1998, major production of alates at this site began in late May and continued through the end of June. A reduced rate of alate production continued through the first of December. Data is current through December 29, 1998, at which time no alates were captured.

Nearfield acoustic communication by ants

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Abstract

An analysis is presented of acoustic communication by ants, including a study of the black fire ant ***Solenopsis richteri.*** Generally, ants' stridulatory sounds are barely audible, but they pervade ant communities and appear to vary with the situation. Since ants are deaf to airborne sound on a human scale, it has been inferred that they communicate using vibrations through the soil substrate. However, from the structure of an ant's body and other evidence, the substrate-transmission theory appears unlikely. A more likely explanation is that ants employ nearfield airborne sound. The acoustic receptors are believed to be concentrations of trichoid sensilla on the two antennae. By using differences in sound displacement between the apical segments of the antennae, ants can receive signals in the nearfield and yet be deaf to sound from the farfield. Also, differences in displacement can determine the distance to a source in the nearfield. Acoustic communication by ants has apparently evolved to take advantage of nearfield sound. Additionally, we have found that the tracheal air sacs of S. ***richteri*** expand to fill the anterior of the gaster. However further research is needed to determine if this is used to amplify the stridulatory signals.

Ants Have an Acoustic World of Their Own

by Robert Hickling, NCPA, University of Mississippi

It is well known that ants do not respond to sound on a human scale. You can shout at an ant and it doesn't seem to notice. Yet many ant species communicate by means of squeaking sounds from a stridulatory organ on the ant's body, consisting of a washboard-like set of ridges and a scraper. The squeaking sounds are usually very faint but they pervade ant colonies. The amplified sound of a colony of black fire ants (Solenopsis richteri), disturbed by a microphone probe pushed into their mound, is given in the attached recording. The sounds can also be heard on the web at www.olemiss.edu/~hickling/. Sounds from individual ants can be heard distinctly and there are a number of different signals. The sounds are in the audible frequency range around 1kHz. Because ants appear to be deaf to airborne sound on a human scale, myrmecologists have inferred that they transmit stridulation signals through the soil, or other solid substrate. However, for a number of reasons, this mode of transmission is highly unlikely. A more likely explanation is that ants communicate with each other through the air using nearfield sound. The nearfield is an acoustic transition zone surrounding a small source, the size of an ant, in which the characteristics of the sound change abruptly before it can propagate fully in the farfield. Usually an ant is a few millimeters in size and the surrounding nearfield is roughly 200 mm in diameter, which is large enough to contain a number of ants. As with other insects, ants are believed to "hear" airborne sound with their antennae, using hair-like sensors at the tips. By sensing the relative difference in sound displacement between the tips of the antennae, an ant can detect a stridulation signal in the nearfield, where displacement changes rapidly with distance, but can not detect sound in the farfield, where displacement changes more gradually. This explains how ants can detect sound from other ants while, at the same time, being unaware of sound on a human scale. This is fortunate for ants because they would otherwise be overwhelmed by background noise, both natural and man-made. As an added bonus, sensing relative displacement between the tips of the antennae provides a means of determining the distance to a sound source, as well as its direction. With human hearing it is possible to determine the direction but not the distance to a source, because the source strength is not known. Humans generally locate a sound source using a combination of hearing and vision. For ants, the relative difference in displacement is independent of source strength and can be used to determine distance directly. Since ants appear to be almost blind, the ability to locate a source purely by means of sound, would obviously be useful.

The nearfield is an acoustic effect that exists independently of ants. Since it is ideally suited to their needs, it would be surprising if they did not use it. In fact it would seem that the stridulatory organ and acoustic receptors of ants have evolved by adapting to the nearfield. Combined with chemical communication using pheromones, acoustic communication plays an important role in ant societies. A more complete knowledge of the nearfield and how ants use it will aid greatly in understanding the role of acoustic communication.

Modeling Range Expansion of the Red Imported Fire Ant in the United States

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There are two major reasons to model red imported fire ant (Solenopsis invicta) populations. The first is its economic importance (e.g., estimated total losses for nine heavily infested southern states are about $2.77 billion annually [Thompson et al. 19951). The second is a technical one: fire ant biology and ecology are comparatively well known (Wojcik and Porter 1997). Consequently fire ants are a good target for using ecological mechanisms to explain their geographic distribution. The current fire ant distribution is shown in Figure 1 and can be found on the WWW (http://www.aphis.usda.gov/oa/antmap.html).

Three attempts to model this biogeographical problem are reported in the literature. A statistical-based work by Pimm and Bartell (1980) used three monthly mean climatic variables (rainfall and number of cold and hot days) in a one-degree latitude x longitude spatial resolution. The authors calculated fire ant propagation rate and applied it to the situation in Texas. A comparison with actual expansion rates over the years showed that the rates were seriously overestimated (see Stoker et al. 1994 for the map of 1993 distribution in Texas).

Stoker et al. (1994) developed a mechanistic model to find a 'reproductive' border that is a point in space where a queen during its life produces exactly one queen surviving to maturity. This mechanistic model describes the joint dynamics of population of colonies and operates using 7 ant developmental stages; it describes queen fecundity, detailed dependence of the developmental rates and mortality on air temperature, and mating flights. The temperature scenario was presented using daily temperatures normally distributed around monthly means. The model was applied to a transect in northern Texas and did not show a distribution limit that matched reality. Mating flights took place and colonies could grow everywhere. As a conclusion, authors suggested that their already complicated model should be complicated further. The central methodical deficiency of their approach is the application of a population-level model (with inter-colony competition) to a problem that likely needs a single colony model.

The third work (Killion and Grant 1995) tried to find a 'growth' border that is a point in space where a fire ant colony ceases to grow. The temperature scenario used was similar to that taken by Stoker et al. (1994). The mechanistic model described single colony development and operated by 5 ant developmental stages. It gave a reasonable location for the fire ant geographical limit, but in very low resolution (three points along a Texas-Kansas-Wyoming transect and one location in Alabama). So, actually only one point on the fire ant range border was determined.

From our point of view, the last two models were overly complicated and contained some features which prevented realistic results. Many details about colony growth are known with low accuracy, and their incorporation into some model does not improve model quality because it makes the model less stable with respect to parameter variations. As we see the problem, model development needs to rely not on the description of a 'real' colony, with more and more details, but on a search for an idealized case which is just sufficient to solve the problem. While an ecologist usually tries to describe his object in detail in order not to lose the reality, a modeler tries to get the desired effects by minimum means. Reality is infinite, so nobody knows *a priori* which necessary and sufficient features one needs to incorporate to reach realistic results. Our variant is offered below.

Soil temperature, T, is the main ecological factor which determines colony metabolism and activity (Markin et al. 1973, Vinson and Sorensen 1986, Porter 1988, Tschinkel 1993).

The most biologically sound way to find a stable border would be to evaluate the "basic reproductive rate," R, making it equal to the average number of queen progeny surviving to adulthood in the absence of intra-specific competition. Then, the needed border is found from the equation

$$R(T) = 1 \tag{1}$$

(Birch 1948, May 1974, Cooksey et al. 1990, Hochburg et al. 1992, De Jong and Diekmann 1992). To find the basic reproductive rate, one needs to know with sufficient accuracy queen fecundity, colony alate production, and queen mortality rate. All three values need to be given as functions of colony size, and ecological factors like soil temperature, and maybe precipitation and competition. This seems to be too much for the current state of knowledge, so several assumptions were made to simplify the description.

First, colonies were described by two dynamic variables - colony area and colony daily alate production. Increases and decreases in colony area are governed by soil temperature. Then, instead of using equation (1) to find the border, we calibrated the model to adjust the calculated range to the extreme points in the insect's present distribution. To do this, total number of alates produced by a colony over its lifetime was considered as a free parameter.

Model construction

The condition or state of a colony at any given age is provided by colony area (Korzukhin and Porter 1994), and by colony alate production per day. Because we have two temperature values for each day, we made two time steps per day. We assumed that the number of workers in a colony is proportional to colony area.

Colony area dynamics. Within our model, two opposite processes determine dynamics of colony area, the production and death of workers. The rates of these processes depend on soil temperature and were determined from laboratory observations (Porter 1988, Calabi and Porter 1989). The details of this modeling process will be presented elsewhere.

Colony alate production. It is supposed that after reaching the reproductive stage, a colony splits its growth resources between worker and alate production. The share of resources directed to alate production is given by a function we call the 'alate production scenario' (Tschinkel 1993). The model assumes that all alates produced fly out of the nest immediately. The details of this modeling process will be presented elsewhere.

A queen establishes the nest at a given Julian date, with initial colony area and lives a given maximum number of days. A shrinking colony dies when it reaches a critical area, which can happen either when it reaches old age or after a sufficiently long period of cold temperature. The main output variable of the model is total number of alates produced by a colony during its lifetime

Temperature data

Data were taken from National Ocean and Atmosphere Administration CD-ROMs; the last year available was 1993. Seventeen states were selected including 12 where fire ant populations are documented (Alabama, Arkansas, Florida, Georgia, Louisiana, Mississippi, North Carolina, Oklahoma, South Carolina, Tennessee, Texas, and Virginia), and 5 states where fire ant infestation are likely (Arizona, California, Kentucky, New Mexico, and Oregon). After eliminating stations with very fragmented data, 3,528 stations were left for model runs. Two types of measurements were used.

1. Direct soil daily maximum and minimum temperature values at 10 cm depth, for 132 stations were used. All soil temperature records started from 1982 or later. Among the stations, 110 had 12 year-long records and 22 others had intervals varying from 4 to 11 years.

2. Daily maximum and minimum air temperatures were available for 3,528 total stations (including 132 'soil' stations). Missing values for the days within a month were reconstructed by interpolation; missing months within a year – by averages; missing years were not reconstructed.

Temperature values from the 132 'soil' stations were used for finding the regressions for the other stations. With few modifications, we applied the formulas of Chang et al. (1994) and Kluender et al. (1993) to calculate soil from air temperatures. The details of this modeling process will be presented elsewhere. For the 132 'soil' stations, the original measurements were used.

Soil temperature values for 10 cm were then corrected to mimic movements of colony population that gave our model 'working' temperatures somewhat warmer than the original ones. Specifically, maximum temperatures were increased to account for warmer mound temperatures during the day. Also, soil temperatures below 4°C were adjusted to soil temperatures at 30 cm to account for movement of the workers to this depth during periods of cold weather.

Model adjustment

To reproduce itself, a queen must produce, during its life, some critical number of alates, which results in precisely one queen surviving to maturity, so the equality of equation (1) will be satisfied. Alate production is determined by alate survivorship probability from birth to maturity, and its real value is known with low accuracy. Field observations give a range from 200 to 10,000 (Markin et al., 1973; Vinson and Sorensen, 1986). Because of this, we decided to find alate production from the empirical fire ant distribution; in other words, the model was calibrated using the observed distribution.

The procedure was intuitive, using observation, our model, and logic. The model was run on all 3,528 weather station locations to get average alate production for each site. We then sorted the data to find sites fitting two criteria: infested with RIFA for several years and having low alate production. The site best fitting this description was in eastern Tennessee, and it had been studied for several years by CMAVE scientists. It showed continued RIFA population survival but winter mortality had been observed. This site set the minimum alate production level for successful colonization, 8,300. This number bears important ecological meaning. Being found for the infested area, it gives the minimum alate production necessary for a queen to reproduce itself. All areas which have alate production greater than 8,300 are likely candidates for infestation. So, we can refer to this area as a zone of 'certain' colony proliferation. This is a 'conservative' forecast because it uses the current range for the fire ant.

If our logic is in error, then perhaps an alate production of 8,300 is too high. What might be an alternative value? To generate another value we selected five sites on the northern border of RIFA range expansion. These infested areas are in Oklahoma, Arkansas, and Tennessee (Figure 2). We generated five circles, with radius equal to about 58 km, to provide about 10 stations per circle. Our logic for doing it went something like this. We know from observation that populations can grow at the center of each circle. Thus, we would expect colonies to survive to the south and maybe to the north. To get a more 'liberal' estimate we then calculated the alate production for each weather station within each circle and selected the site with the lowest "reasonable" alate production, which was 4,500. We tossed out two of the 53 sites because they produced very low values (50 alates in Arkansas and 1,013 alates in Tennessee). This became our second level of range expansion. A third level are stations that generated less than 4,500 total alates. Fire ant populations are not likely to be maintained there.

When and if fire ants reach the areas and sites with projected lower alate production, we will need to repeat the adjustment procedure and the zone of certain colony proliferation success will need to be increased.

Arid or semiarid conditions should hamper fire ant advance because of restricted habitat productivity and possible direct effects to the fire ant's life cycle (e.g., increasing difficulties in nest finding). There are no reliable data of this kind, so we took a precipitation threshold of 510 mm/yr, as a reasonable value limiting fire ant range; it corresponds to a semiarid region in southern Texas with reported spotty fire ant findings (personal communication). However, fire ants should do just fine in arid areas that are irrigated or adjacent to natural water courses.

Results and Discussion

Figure 2 shows the predictions generated for Arkansas, Oklahoma and Tennessee, while Figure 3 shows it for the 17 states analyzed. Plus signs indicate stations fitting our conservative estimate (**YES**), and the dark squares the liberal estimate (**MAYBE**). Open triangles depict sites with cold temperatures that probably limit fire ant survival (**NO**).

Mixed symbols represent the transitional zone where YES, MAYBE, and NO stations are mixed. The apparent reason for this "fuzzy border" is the spatial heterogeneity of weather (temperature) data. At what degree survival is caused by the intrinsic temperature spatial variability, and at what by the heterogeneity of the habitat (e.g., soil cover and relief) is another question. The existence of the fuzzy border is also the reason for the liberal and conservative estimates discussed above.

Some features of the predicted distribution can be noted. In a smaller scale (Figure 2), the liberal zone considerably exceeds the current range. The model predicts 120-150 km northern extension in Oklahoma, the same size northeast extension in Arkansas, and 80-100 km northern extension for Tennessee.

The conservative estimate is best if the current distribution in these three states has reached or nearly reached its maximum limits. The liberal estimate is probably better if fire ants have only just invaded the most southerly locations along this fuzzy border at which they can survive. Fire ants still appear to be moving northward at a slow rate in Oklahoma, Arkansas, and probably Tennessee; consequently, the liberal estimate may provide a better estimate of sites at which fire ants have demonstrated their survival ability.

For the whole fire ant range (Figure 3), the model predicts considerable broadening of the current range, mainly in maritime areas of Virginia, western areas of Texas, and wide regions of California and Oregon. Low precipitation will likely seriously restrict fire ant propagation in the area between western Texas and eastern California, with exception of irrigated areas.

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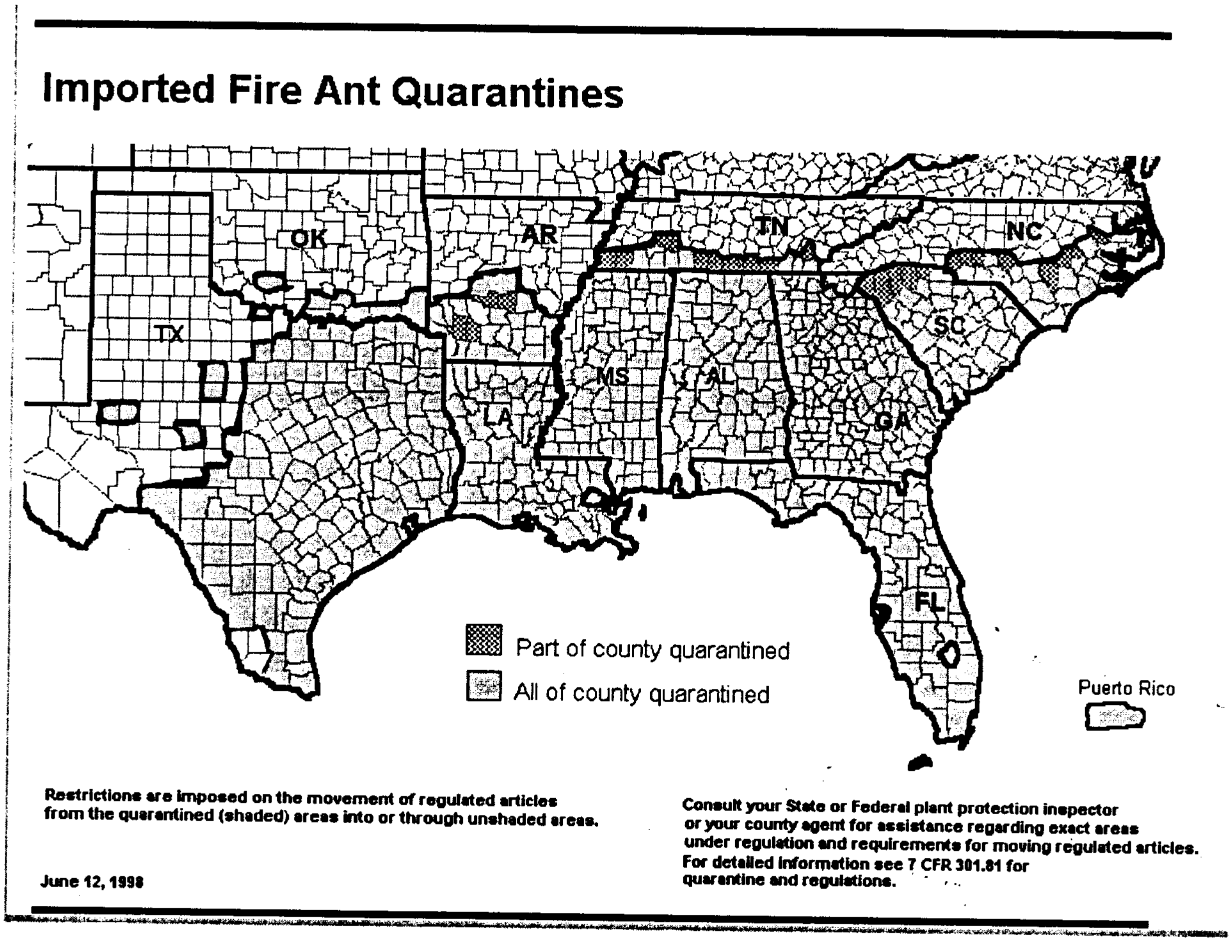

Fig. 1. Imported fire ant quarantine map - 1998.

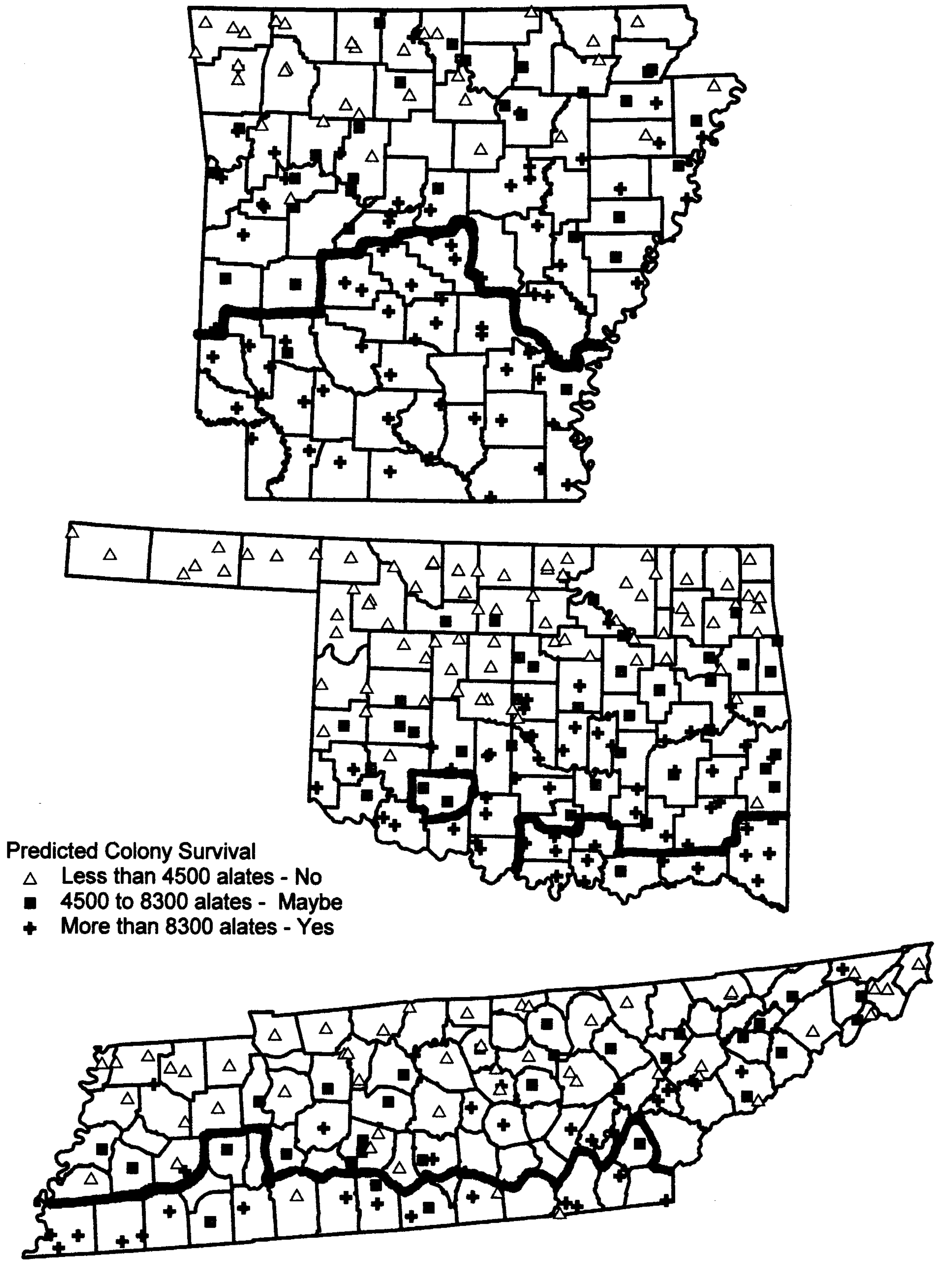

Fig. 2. Three partly infested states selected for model calibration. Currently infested areas are below the thick lines.

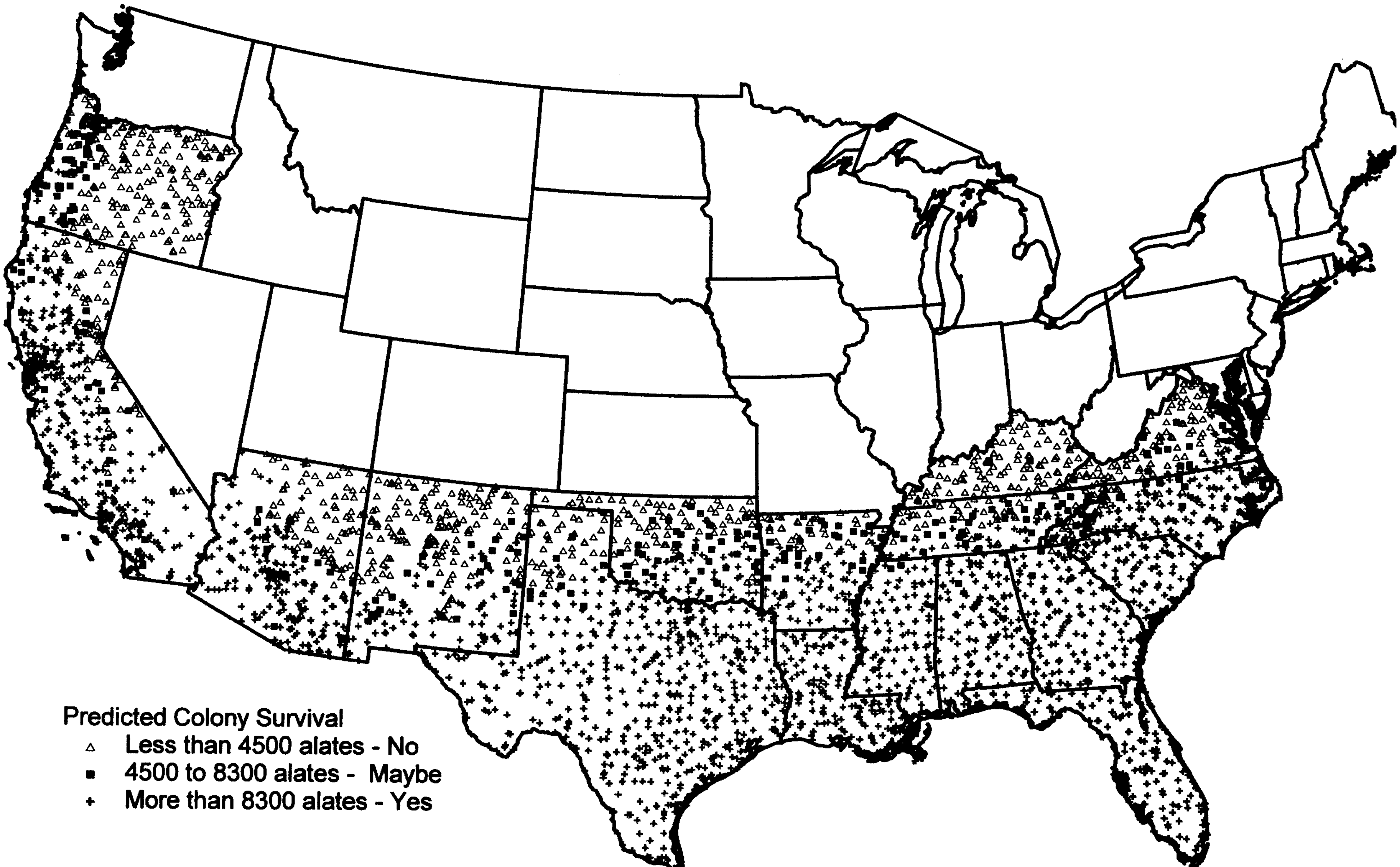

Fig. 3. Predicted RIFA colony survival across the United States.

Potential Red Imported Fire Ant Range Expansion - A GIS View

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INTRODUCTION

The advancing occupation of the Red Imported Fire Ant, *Solenopsis invicta* Buren, (RIFA) has caused much concern in southern and western areas of the United States. Because tremendous economic losses are at stake, it is imperative that we understand where and why future invasions may occur. Many attempts have been made to modei RIFA range expansion (Pimm and Bartell, 1980; Cokendolpher and Phillips, 1989; Stoker, et al., 1993; Killion and Grant, 1995; Korzukhin, et al., 1997; Weih and Thompson, 1997; Thompson, et al., 1998). Thompson, Korzukhin and Porter (1999) have elaborated on their previous colony growth model and have predicted population range expansion from Virginia to Oregon. This paper uses Geographic Information Systems (GIS) software tools to visualize and spatially analyze the results of this model for 10 states.

MATERIALS AND METHODS

This GIS overview of RIFA range expansion was accomplished using Environmental Systems Research Institute, Inc. (ESRI) ArcView 3.1, along with the Spatial Analyst extension. Data layers were provided for Arkansas by the Spatial Analysis Laboratory at the School of Forest Resources, University of Arkansas, Monticello. Data layers for other states were obtained from the ArcUsa 1.2m database developed by ESRI and from the Conterminous US Land Cover Characteristics Data Set developed by the University of Nebraska, Lincoln.

The principal data set for this GIS overview reflects predictions of the dynamic model of colony survival described by Thompson, et al (1999). The data set contains over 3500 records. Each record reflects an estimate of total average life-time alate output of a colony for each weather station location. Colony growth rates were predicted based on certain life history parameters along with maximum and minimum soil temperatures. Total colony alate production was used to define three zones to estimate whether or not a population could be maintained. Production of 8300 or more alates will assure population survival. If alate production is between 8300 and 4500, the population may survive. If alate production is less than 4500, it is doubtful that the population will survive. Each record/weather station is identified by latitude and longitude in degrees, minutes and seconds. Station locations were transformed to decimal degrees, imported into an ArcView project, and projected to Albers Equal-Area. State and county boundaries were overlaid on the alate data. State boundaries and the three zones of predicted colony survival are depicted for southern and western United States in figure 1. Infested counties were identified based on the USDA-APHIS quarantine map of June 12, 1998. The results of these layers (predicted colony survival, state and county boundaries, and infested counties) are shown for 10 states on the advancing edge of RIFA invasion (figures 2-11).

For the state of Arkansas, additional data layers were used to further investigate factors which may influence colony survival. These layers included elevation, aspect, land cover, urban areas, and soil types. GIS provides an ideal tool to illustrate and spatially analyze these relationships where appropriate data are available. Efforts were also directed toward evaluating various methods of kriging using the spatial analyst extension of ArcView. Kriging is an advanced interpolation procedure that generates an estimated surface from a scattered set of points.

DISCUSSION

Predicted RIFA range expansion described by Thompsons' model drastically increases the current range. It is likely that fire ants may move into several western states where they have not yet been reported, as well as expand northward in southern states along the perimeter of their current range. Although fire ant range expansion is ultimately limited by temperatures set for colony mortality (Calabi and Porter, 1989), there are numerous other mitigating factors that may influence colony survival at a local scale. Water in the form of rainfall or irrigation is the most obvious factor. Because timing and the amount of precipitation is important to fire ant productivity, the model doesn't work well for arid regions. However, irrigated tracts are likely to mimic areas where precipitation is ample, making the model reliable for those areas.

Other relevant factors include elevation, aspect, land cover, and urban activity. The inclusion of these factors produces a heterogenious landscape for colony development. The validity of predicted colony survival at a specific point may be investigated using GIS. Data layers may be spatially analyzed to determine how the above factors may influence a colony in that particular location. It is important to consider the relationship of these factors, in addition to soil temperature, when analyzing the probability of population survival in a specific environment. Colonies are less likely to survive at higher elevations and more likely to survive on southern and western facing slopes. Colonies are more likely to survive in pasture or crop areas than in forested locations. Colonies are more likely to survive in urban areas where conditions are modified by human activities.

CONCLUSION

GIS provides the tools to build a spatial model using physiographic features to predict temperature suitability for RIFA colonization on a local scale. Spatial statistics techniques in a GIS framework can be used to incorporate heterogeneity into a landscape model. After additional research to determine the relative importance of individual mitigating factors, this model could be used to refine the predictions of the dynamic model developed by Thompson, et al (1999). Reliable forecasting of colonization success in areas threatened by RIFA infestation will allow policy makers and administrators to plan, fund, and implement regulatory activities. This may save millions of dollars in economic loses attributed to fire ants.

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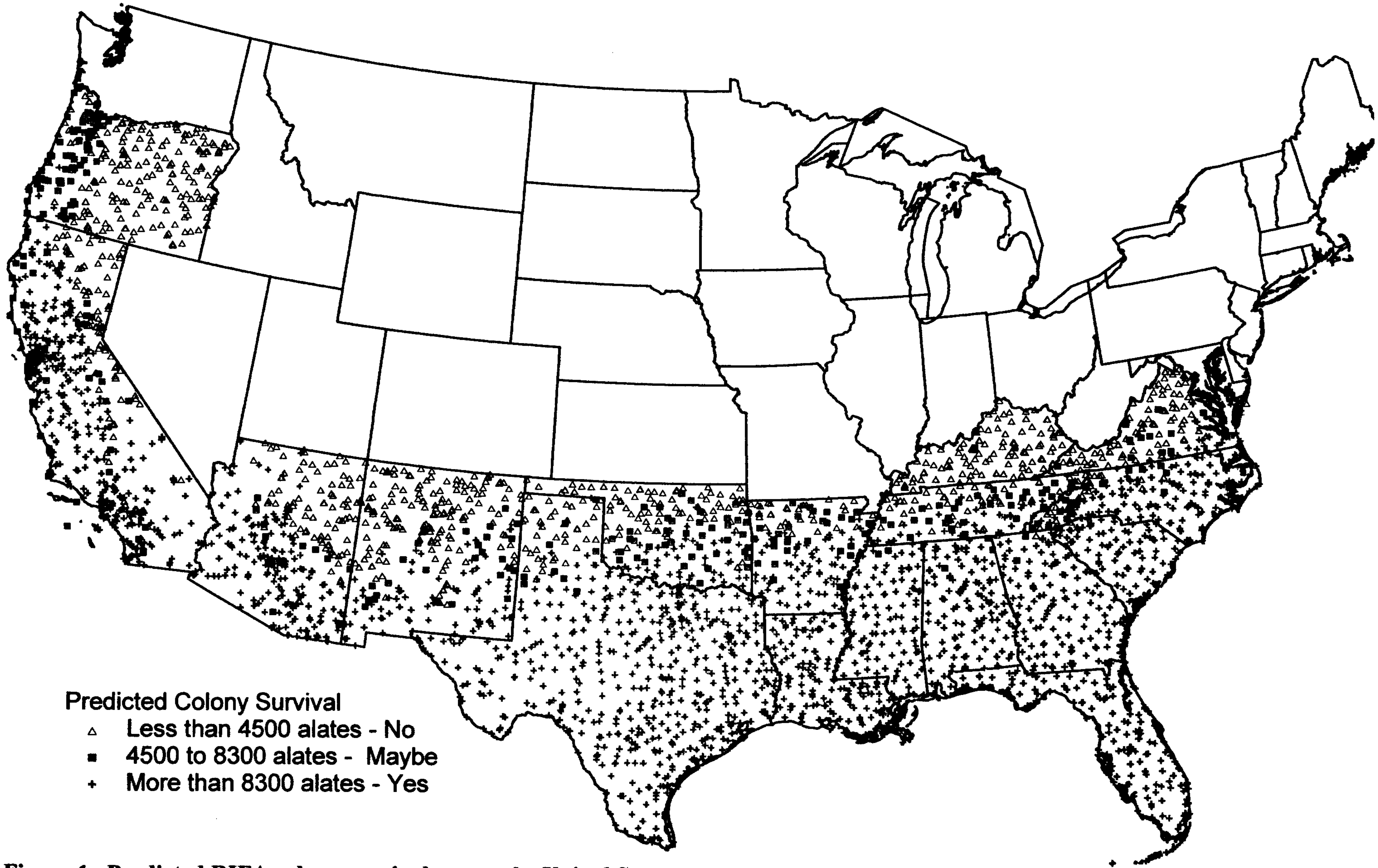

Figure 1. Predicted RIFA colony survival across the United States.

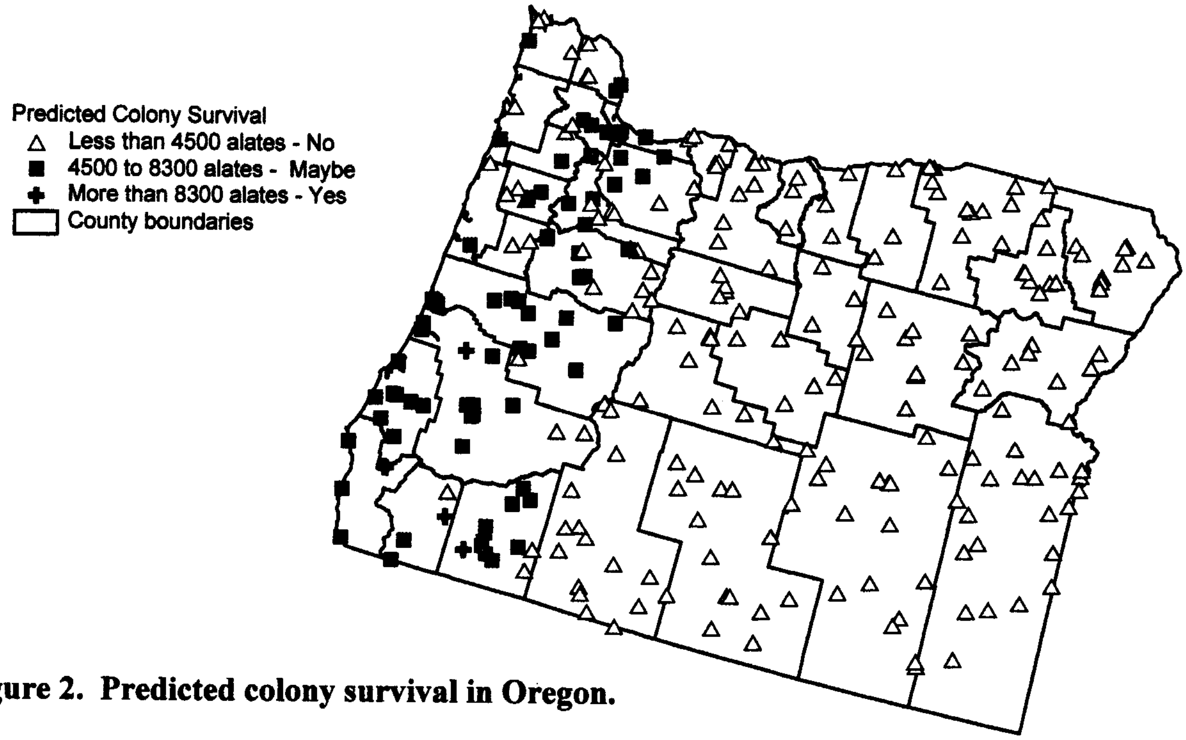

Figure 2. Predicted colony survival in Oregon.

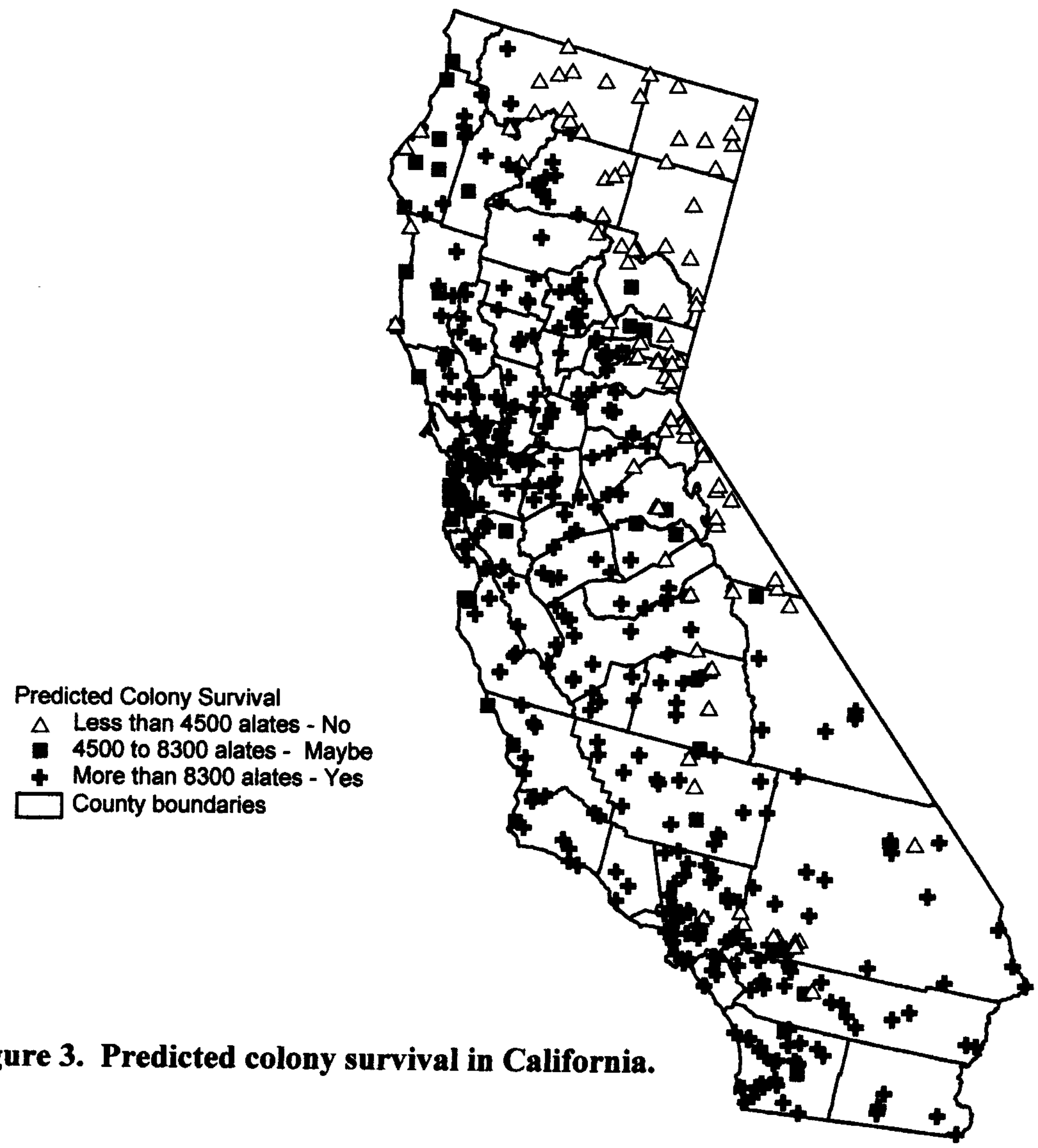

Figure 3. Predicted colony survival in California.

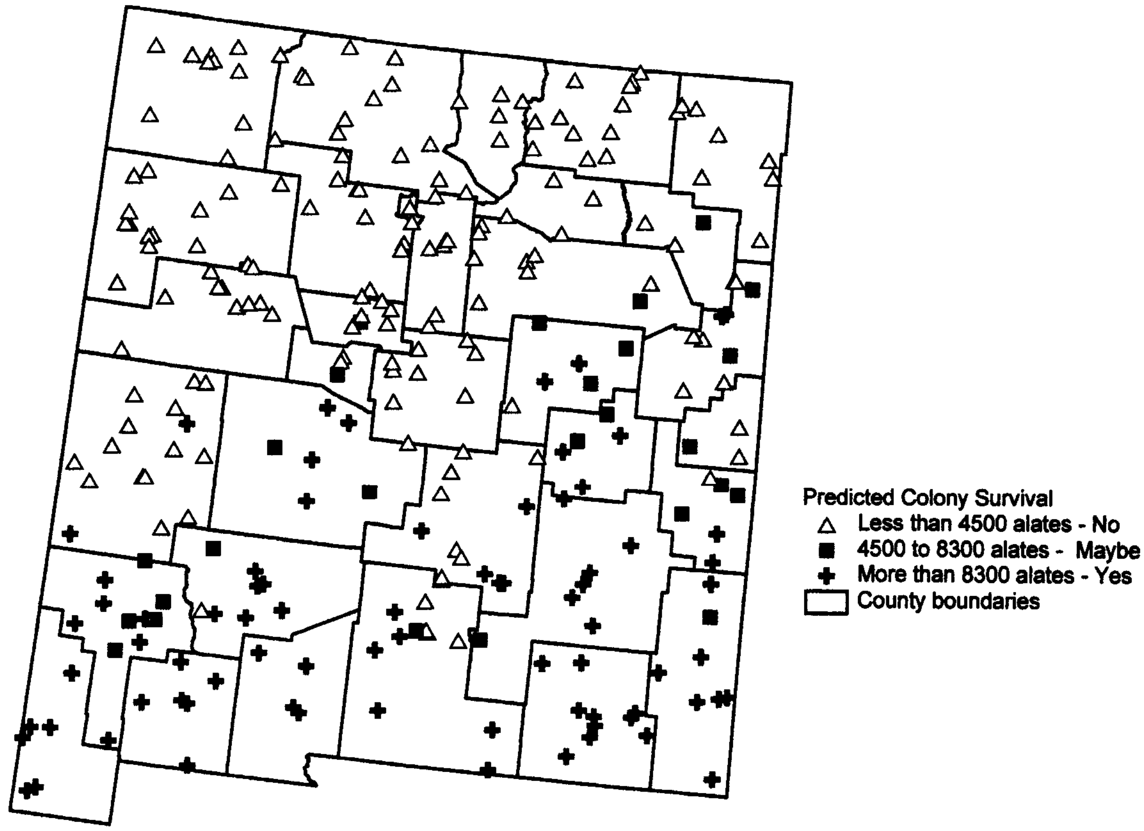

Figure 4. Predicted colony survival in New Mexico.

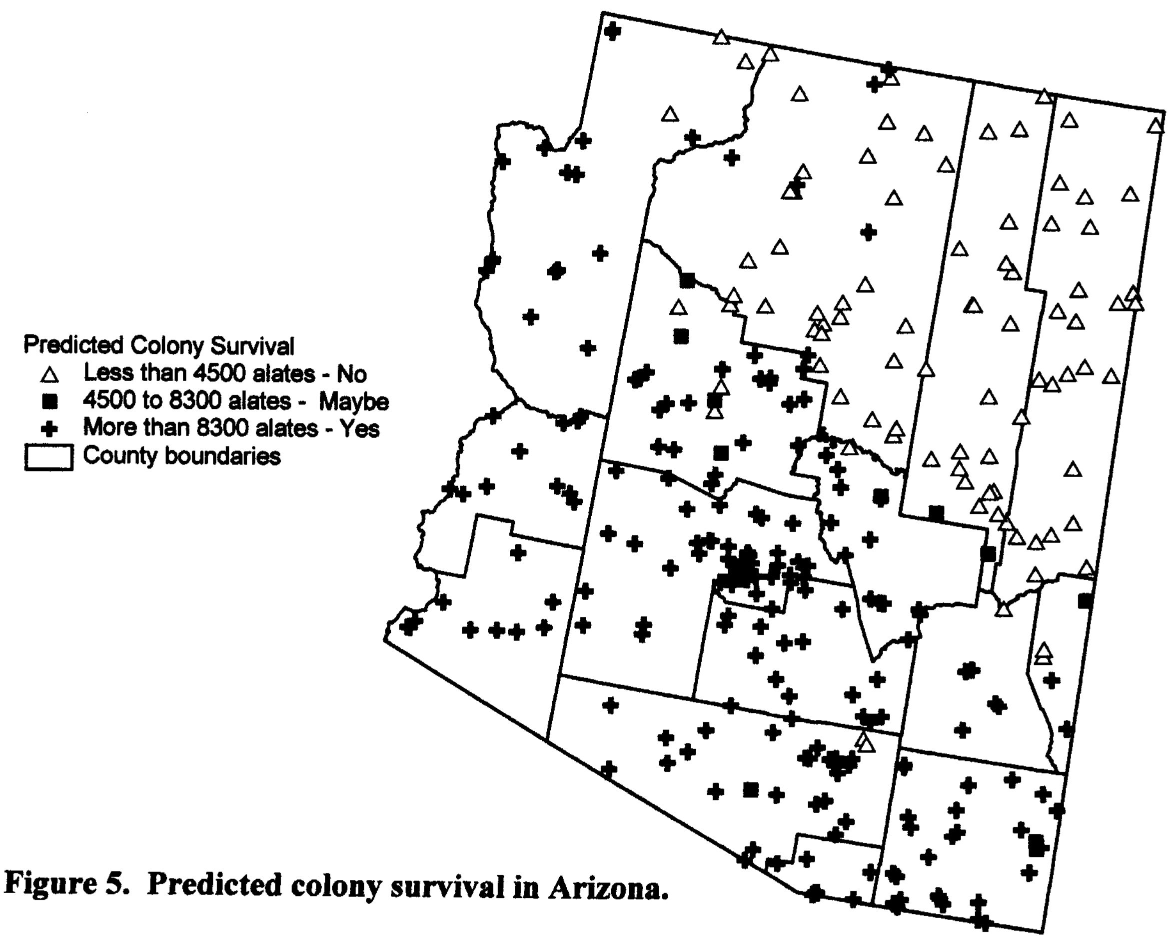

Figure 5. Predicted colony survival in Arizona.

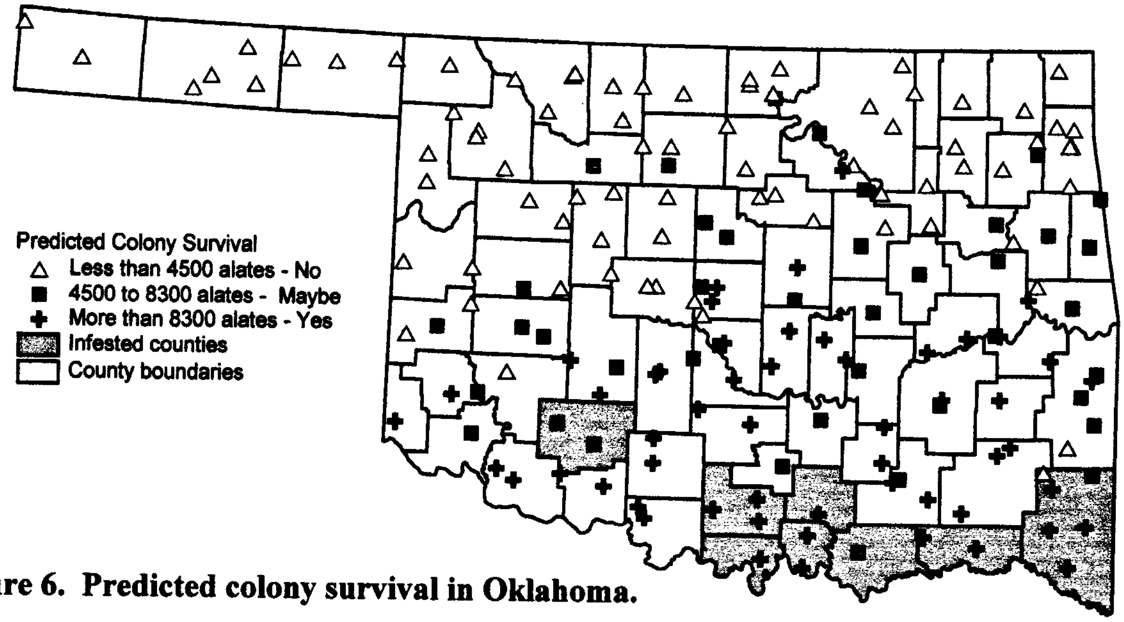

Figure 6. Predicted colony survival in Oklahoma.

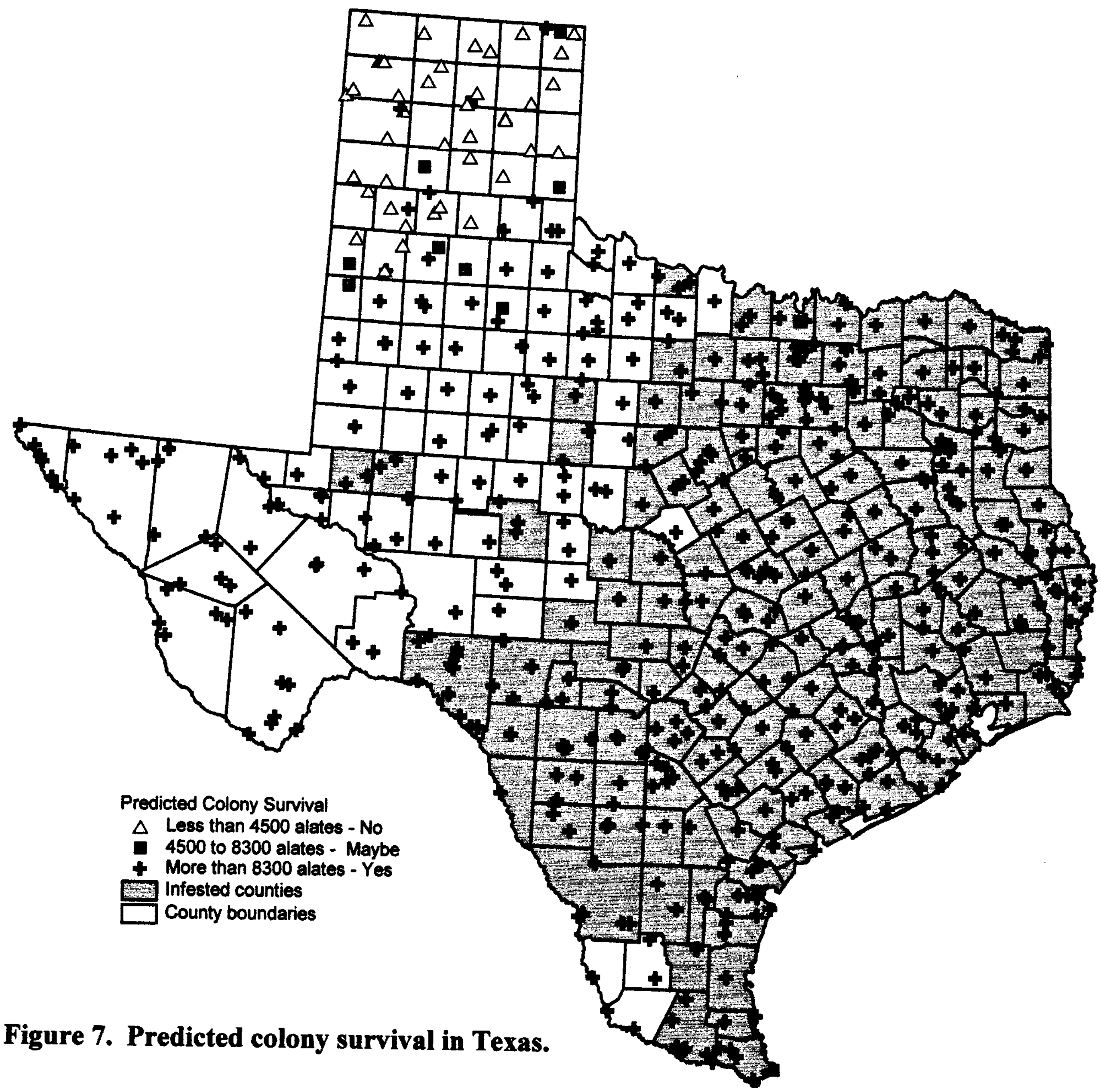

Figure 7. Predicted colony survival in Texas.

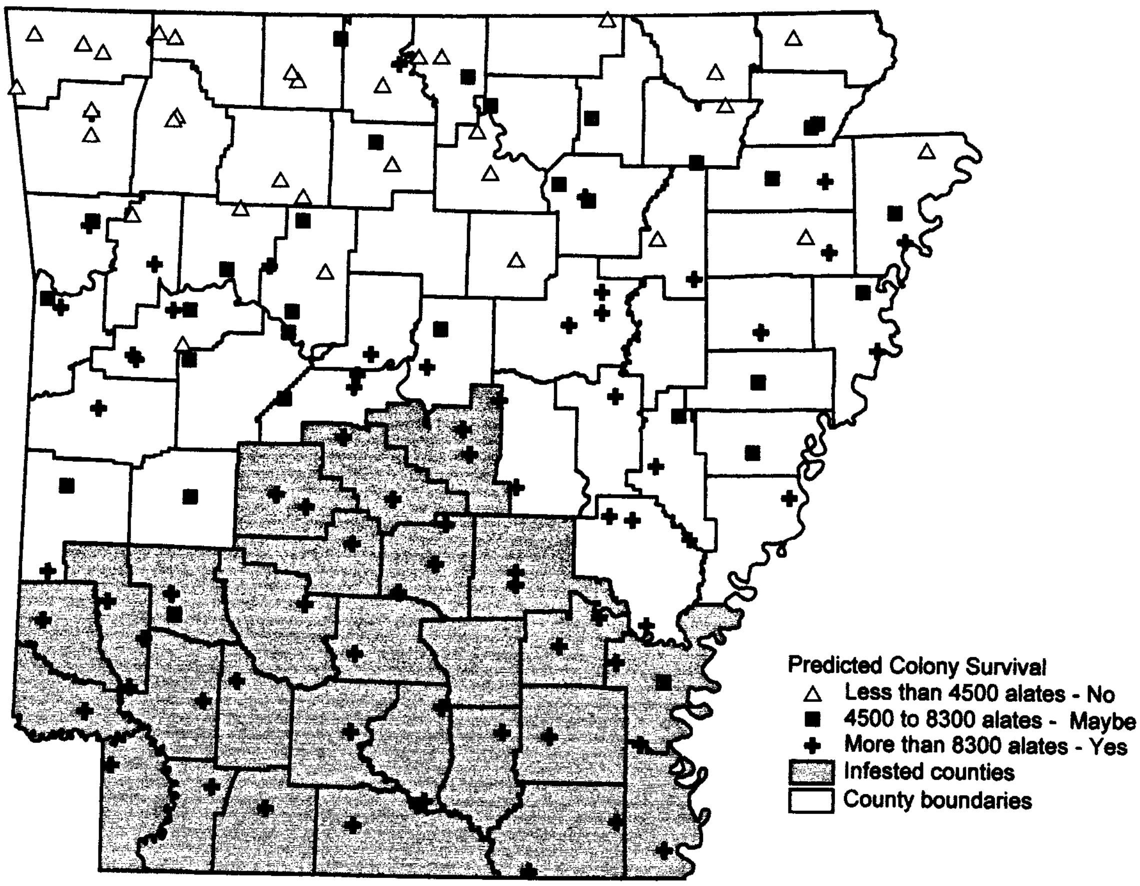

Figure 8. Predicted colony survival in Arkansas.

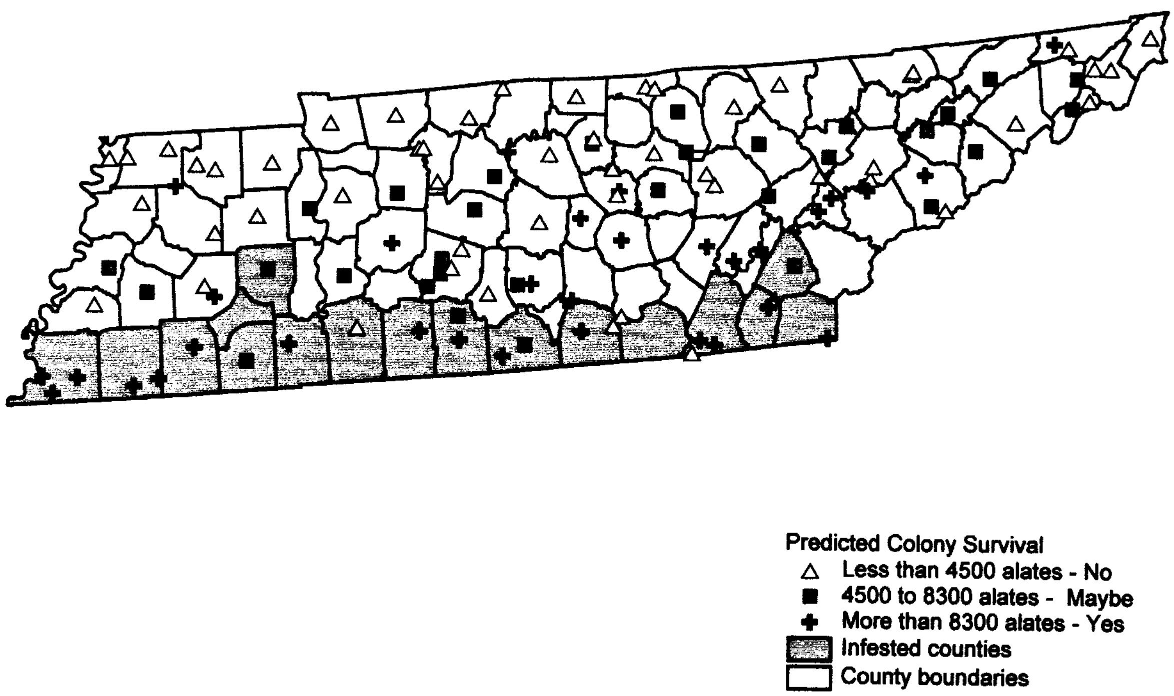

Figure 9. Predicted colony survival in Tennessee.

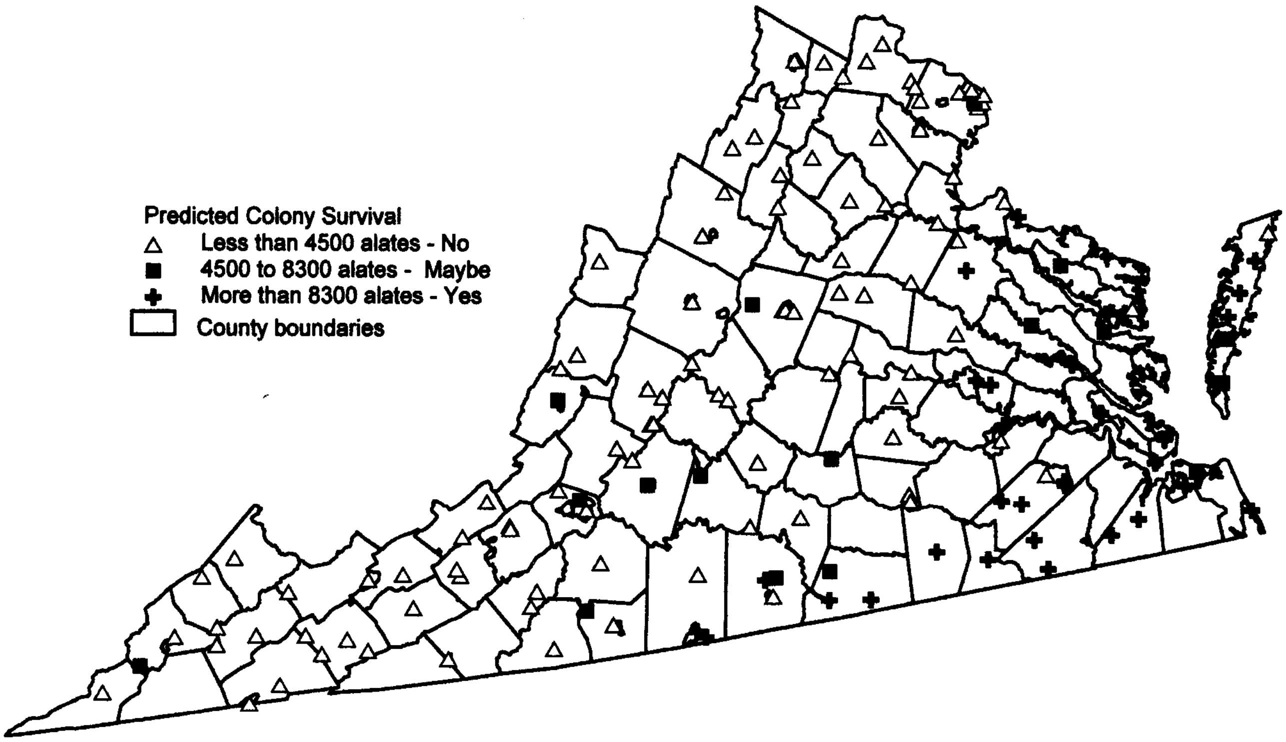

Figure 10. Predicted colony survival in Virginia.

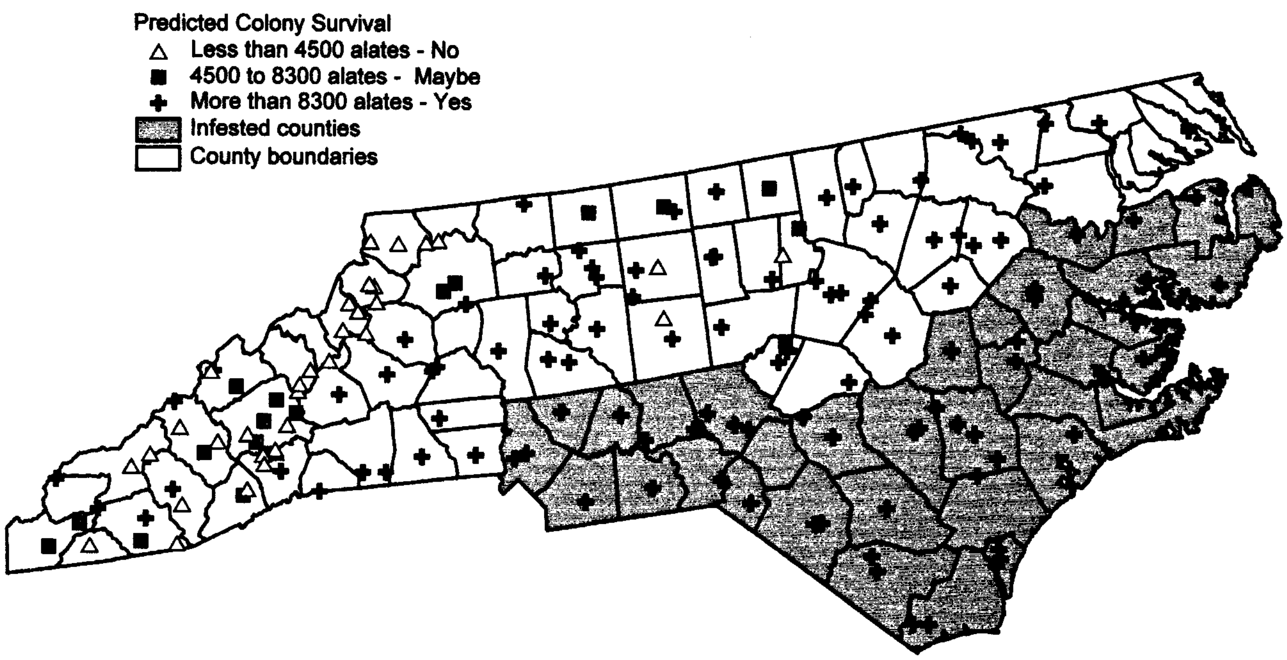

Figure 11. Predicted colony survival in North Carolinia.

Red imported fire ant distribution and mound size under different cropping systems

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The red imported fire ant, ***Solenopsis invicta*** Buren, may build large mounds which can present a problem to growers. When farm machinery hits large mounds, considerable damage may result. Although it is known that soil type, cultivation, and vegetable cover influences both mound size and distribution, few specifics are known. It is the objective of this study to show what influences different cropping practices may have on fire ant distribution and mound size. A fourteen acre field on the Pee Dee Research and Education Center was split roughly down the middle. One half has been farmed using conventional cropping practices (varieties, row spacing, tillage, fertilizer, etc.), the other with more innovative practices (including narrow row spacing and minimum tillage). The entire field was planted in corn in the spring of 1998. After harvest, the corn was followed by soybeans. Shortly after soybean planting (June 1998), fire ant infestations in the field were 9 moundslacre in the conventional side, and 5 moundslacre in the innovative side. After soybean harvest (October 1998), there were 18 moundslacre in the conventional side, and 44 moundslacre in the innovative side. All mounds were mapped on both occasions using GPS technology. Although these are just preliminary results, the data demonstrate that it may be wise to consider fire ant populations when making other farming decisions. These studies are continuing, and relative mound size in the two halves of the field will be determined prior to planting of the next crop.

A Cost/Efficacy Comparison of Individual Mound Treatments (IMT) and Broadcast Baits

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Bastiaan M. Drees, Fire Ant Project Coordinator

Introduction

There are two basic types of pesticide treatments used for the control of red imported fire ants ***(Solenopsis invicta*** **Buren**): individual mound treatments (IMT) and broadcast baits. There are literally dozens of IMT products available employing a variety of application methods. In recent months there has also been a dramatic increase in the number of conventionally-formulated broadcast bait products available, as well. Though most are labeled for use as **IMT's,** the distinguishing characteristic of these products is that they can be scattered over an area at very low rates without the need to locate and treat individual fire ant colonies. Conventionally-formulated baits consist of three components: a defatted corn cob grit granule, soy bean oil that acts as both **carrier** and attractant and the active ingredient. These products are almost identical in appearance, application method and application rate, varying mainly in their speed of action and duration of control.

The purpose of this test was to compare the cost and effectiveness of several individual mound treatment products, representing the major application methods, and the two major classes of conventionally-formulated broadcast baits, toxicants and insect growth regulators (IGR's). The test was designed to simulate homeowner-type applications on yard-sized plots to get a more accurate representation of the time and labor involved in application.

Materials and methods

The test was located in an ungrazed pasture in western Brazos Co., Texas. Soil in the pasture was a dark, heavy clay which resulted in large, grass-covered fire ant mounds of a height and density that made driving, and even walking, difficult. Vegetation consisted of unimproved sod and bunch grasses. Fire ants were believed to be of the polygyne (multiple-queen) type based on colony densities that averaged 150 mounds per acre. Prior to test initiation in October 1997, the area had endured four months of virtually **no rainfall** with daytime highs above 95°F. The first rains of fall began in late September, about two weeks before test initiation. Consequently, though fire ant mounds were physically large, the colonies were rather small in population and tended to occupy only a part of the mound structure.

Test plots consisted of 0.25 acre squares (105 x 105 feet) with a central circular sampling area. Initial active mound counts were first taken in a circular sampling area 30 feet in diameter using the minimal disturbance technique where mounds were disturbed with a pointed tool handle. If a sufficient number of ants rose to the surface in a defensive manner, the mound was considered active. Active mound numbers were then arrayed from highest to lowest and divided into four equal sets (replications). Treatments were assigned semi-randomly within replications so that the total number of mounds for each treatment (all four replications) were as equal as possible.

Since the evaluation area would also be used as the treatment area, it was found that some of the plots did not have a sufficient initial number of active mounds for a good test. There was also considerable variability within the low and high density replications. Rather than lay out and evaluate more plots or re-evaluate existing ones and re-assign treatments, it was decided to use a larger, 40-foot radius circle for sampling and treating, with pre-count numbers to be determined at the time of treatment.

In plots designated to receive IMT treatments, two workers surveyed the central 40-foot radius circle of each plot and marked all active mounds with wire flags. Active mounds were counted, but not marked, in plots designated to receive no or broadcast bait treatments. Circles were determined by placing a stake in the center of the plot and following a 40-foot long tape around the entire area marking all encountered active mounds. Treatments were done on 17 October 1997. Weather was partly cloudy, 75-85 °F with moderately moist soil. The following treatments were applied:

Treatment	Application rate	Application Method
chlorpyrifos, 6.6% liquid	1 fl. oz./md.	IMT, 1 gal. pre-mix drench
diazinon, 5G	1/3 cup/md.	IMT, + 1 gal. water drench
diazinon, 5G	1/3 cup/md.	IMT, dry granules only
acephate, 75S	2 tsp./md	IMT, dry dust on mound
hydramethylnon (Amdro®)	5 TB/md.	IMT, dry granules
hydramethylnon	1.5 lb./acre	broadcast
fenoxycarb (Logic®/Award®)	1.5 lb./acre	broadcast
untreated	–	--

Plots were treated one at a time by two workers and times were kept on all phases of the treatment process. Drenches were applied with two-gallon plastic watering cans and dry treatments with kitchen measuring spoons to simulate likely homeowner use of the products. Broadcast baits were applied using a Cyclone 1C1 hand-held spreader by a third worker late in the day. Since the 40-foot radius circles had no perimeter markings and time was running short, it was decided to treat the entire 0.25 acre plots of all broadcast bait treatments.

Evaluations of active mounds were conducted using the minimal disturbance technique at 18 and 35 days, and 13, 23, 34 and 60 weeks post-treatment. Since the time it takes to apply IMT's varied with mound density, application times were standardized to the mean mound density of the area, 150 mounds per acre. Mound location times were averaged for all applicable plots. Labor rates were calculated at $6.00 per hour per worker. Product prices were obtained from local Bryan/College Station, Texas retailers on 9 June 1998.

Results

Consolidated results are described by the following figures. Statistical data are not included here as they are awaiting publication in a final report to the sponsoring companies.

Figure 1. Analysis of treatment cost by task.

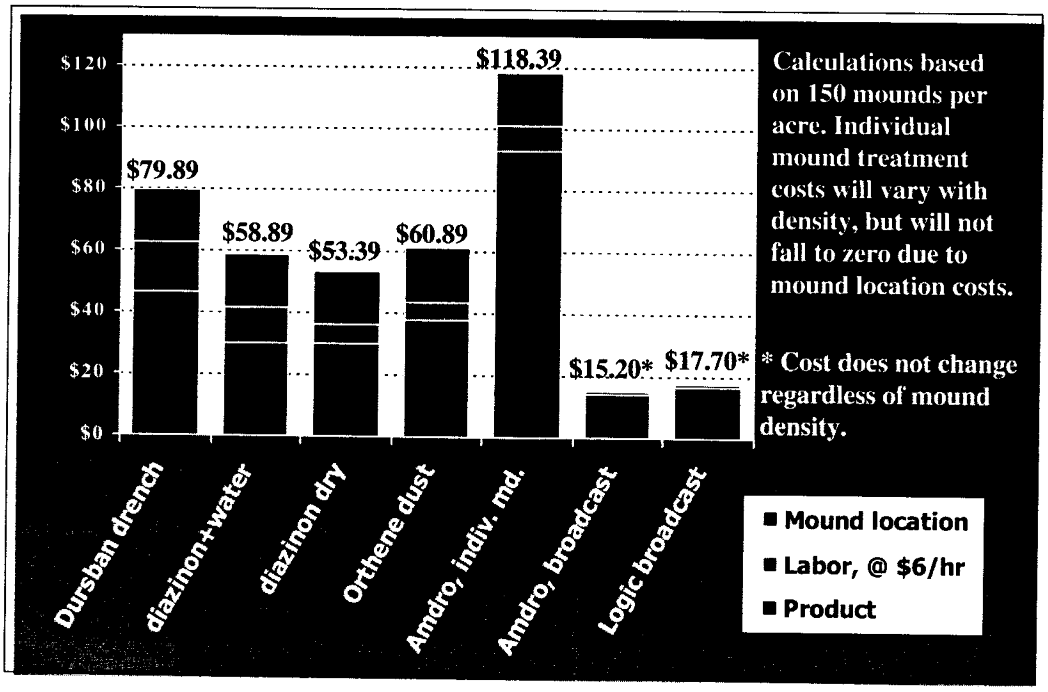


Figure 2. Summary of individual mound treatment efficacy.

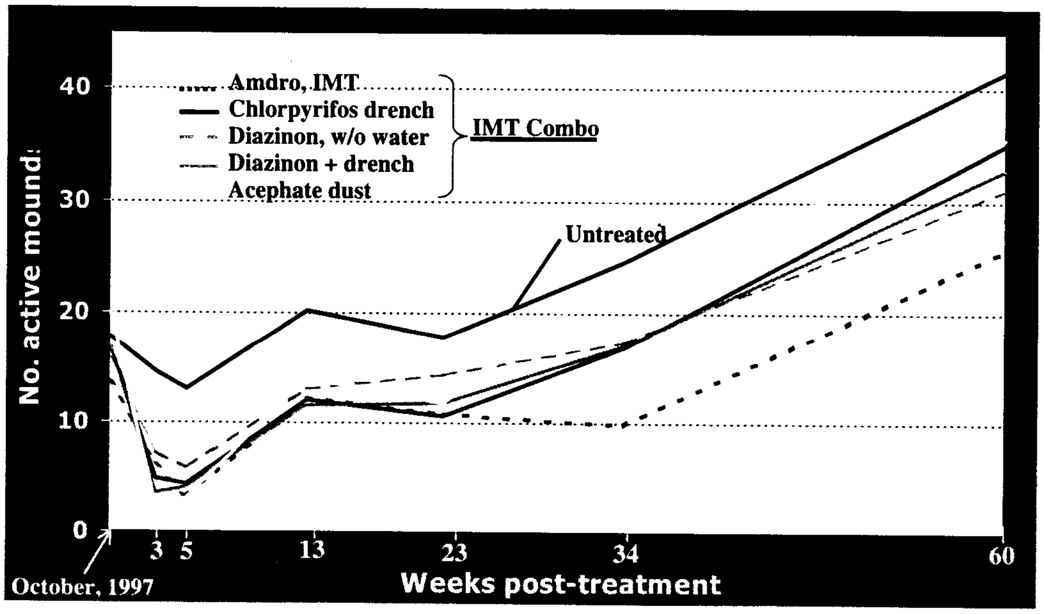
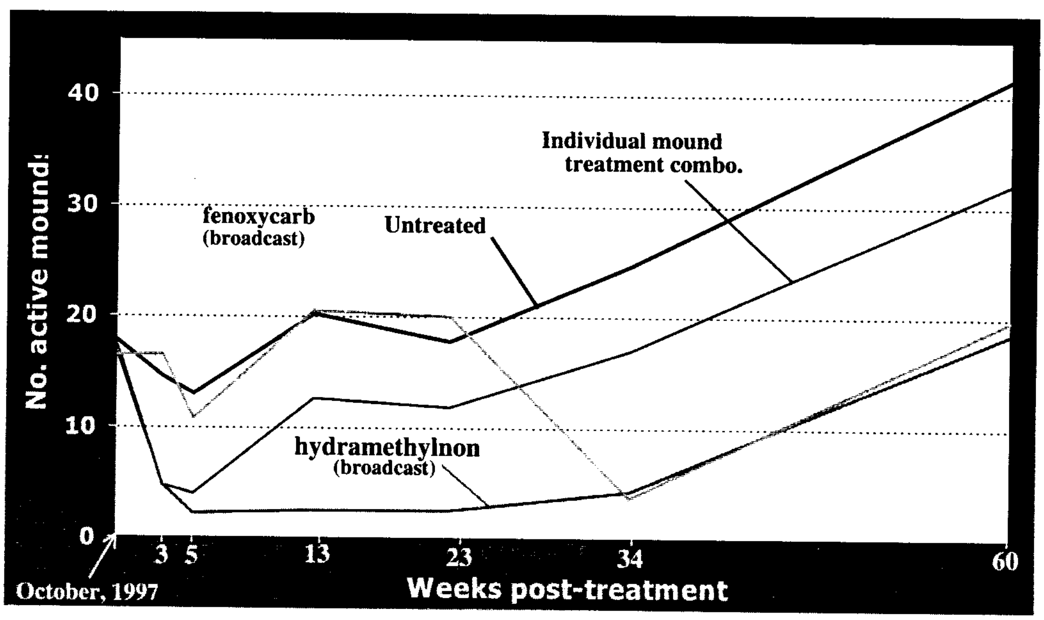


Figure 3. Summary of mound treatment combination versus broadcast bait treatments.



Discussion

As can be seen in **Figure 1**, the labor and product costs of IMT's are several times higher than those of broadcast baits at a standardized mound density of 150 mounds per acre. Costs of IMT's would drop more-or-less proportionately with increasing or decreasing mound density, but would never drop to zero because of the time it takes to survey for active mounds, even if there are few or none present. In this test, just locating mounds cost an average of $17.39 per acre. Broadcast bait applications do not require the location of mounds, of course, so there are no costs associated with that step.

Also note the differences in proportion of total cost for the IMT's. Amdro® (hydramethylnon), used as an IMT, cost about $0.62 per mound, whereas the other IMT products cost $0.20 - $0.31 per mound. On the other hand, the labor involved in mixing chlorpyrifos then carrying it to mounds and drenching them cost nearly $0.11 per mound ($16/acre) where the other methods cost from $0.04 - $0.076 per mound ($6 - $11.50/ac).

Figure 2 illustrates that all IMT's performed almost identically in terms of active mound elimination from three through 23 weeks post-treatment. No statistical differences ($P < 0.05$) appeared among the IMT's until 34 weeks post treatment.

Based on their similar performance, the IMT's values were consolidated in **Figure 3** for clarity. Note how hydramethylnon applied as a broadcast bait performs similarly to the IMT's through five weeks post treatment. This speed of mound suppression (65% reduction in 18 days) is unusually fast for a broadcast bait. It is speculated that the small, summer-weakened colonies were foraging very actively at the time of treatment in order to rebuild. Consequently, the ants retrieved a high proportion of bait particles, thereby concentrating the toxic effects of hydramethylnon in relatively few worker ants.

The effects of broadcast Logic/Award (fenoxycarb) were quite the opposite. It took over seven *months* for this IGR treatment to reach maximum mound suppression. Field observations indicated that worker brood disappeared as expected, but workers died at a very slow rate. This low natural mortality was probably due to the cool, wet winter and spring experienced in 1997-98. Shortly after the 23 week evaluation, rainfall in the area virtually stopped and temperatures were unseasonably high - the likely cause of the steep drop in active mound numbers in fenoxycarb-treated plots.

One of the most notable points in **Figure 3** occurs between five and 13 weeks post-treatment. During this interval, IMT active mound numbers return to near pre-treatment levels, while hydramethylnon-treated plots stay near maximum suppression. This trend continues through 34 weeks post-treatment. At this point, it is best to discuss a potential flaw in the experiment. As mentioned earlier, entire 0.25 acre square plots were treated with broadcast baits due to circumstances at the time of treatment, whereas only the central 0.115 acre circle of IMT plots were treated. It is possible that the IMT plots had a higher rate of re-infestation than broadcast-treated plots due to the treated buffer around broadcast plot sampling circles.

However, there are a number of reasons to suspect that the difference in plot sizes may be only a minor factor in the rapid increase in active mound numbers in IMT-treated plots. With 105-foot square plots and an 80-foot diameter sampling area, the circle is within 13 feet of the plot edge on four sides, hardly a major barrier to re-infestation though the buffer is larger in corners.

Most importantly though, the slope of the fenoxycarb-treated plot line, the IMT

Landscape ecology of the red imported fire ant in a post oak savanna

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Introduction

Although the knowledge based on the ecology of the red imported fire ant is robust (Vinson 1997), the causes for change in the distribution and abundance of the insect in landscape mosaics are poorly understood. At a mesoscale (100 to 1,000,000 ha), the fire ant can be viewed from a metapopulation perspective (Doak and Mills 1994, Gilpin and Hanski 1991). Infestations represent a collection of populations. The populations are clustered in suitable habitat patches, which are dispersed throughout the landscape. The habitat patches are spatially separated by environmental conditions that do not support insect growth, survival, and reproduction. The habitat patches are linked through dispersal behavior of adult insects. An important research question, relevant to IPM of the fire ant, centers on how the spatial arrangement of habitat patches influences the distribution and abundance of the insect across complex landscape mosaics. This question is also of fundamental importance in landscape ecology and it has been examined in detail by Coulson et al. (1996) and (1999), Dunning et al. (1992), Azevedo et al. (1999), Pickett and Candenasso (1995), Pulliam et al. (1992), Saunders et al. (1993), Turner (1987) and (1989), Turner et al. (1993) and (1995), and Urban (1993).

Our goals in this study are to examine how the fire ant perceives and responds to heterogeneity in mesoscale post oak savanna landscapes. Both the content and context of the spatial elements forming the landscapes are considered, as human-caused fragmentation and natural disturbances create mosaic patterns where the specific arrangements of components can enhance or inhibit the distribution and abundance of the fire ant (Lofgren and Vandemeer coordinates were uplinked to a Trimble Pathfinder II GPS unit receiver as waypoints. At the sample point, the GPS operator collected a minimum of 20 GPS epochs and logged the collected data fields into the GPS integrated data collector. Sampling was conducted in May-June 1998, Aug-Sep 1998, Dec 1998, and Feb 1999. The timing of sampling corresponded to the maximum activity of fire ants in the area determined from previous experience.

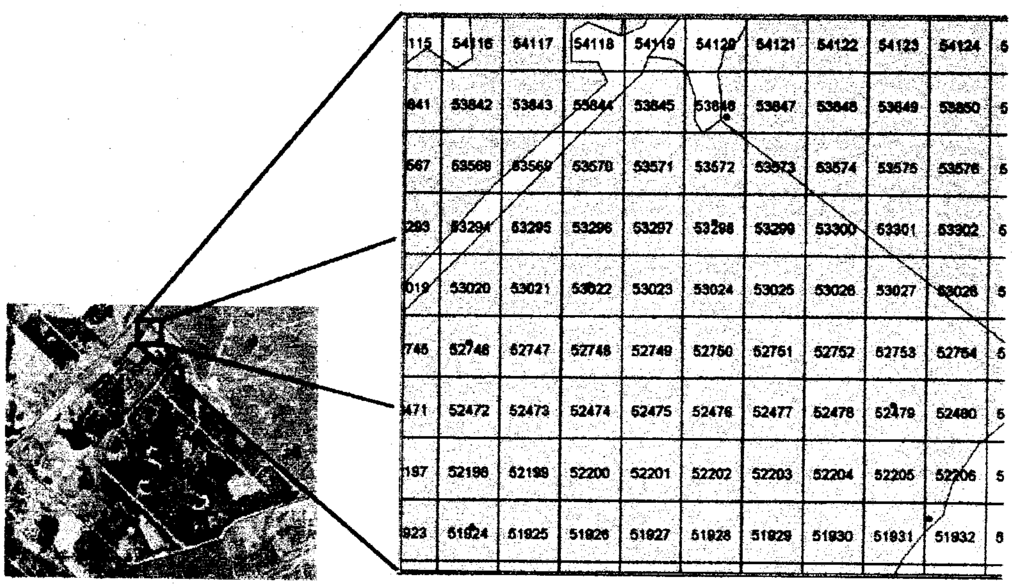

Fig. 1. Example of grid overlay of mosaic showing unique numbers used for randomized sample plots.

Results

Distribution of sample plots. Over 500 plots were sampled in the study area. Spatial distribution of sample plots, scored into four size categories of increasing density, is displayed over a mosaic of the study site (Fig. 2). A drape of fire ant mound densities over the study site is displayed in Fig. 3, with the areas of greater mound density represented by darker shades of color. Fig. 4 represents a 3-dimensional oblique perspective of the mound density information displayed over a land cover classification of the study site.

Fig. 2. Distribution of sample plots and density of mounds. Open circles = no mounds, small circles = 1 – 5 mounds, medium circles = 6 – 10 mounds, large circles = 11 – 15 mounds.

Fig. 3. Drape (extrapolation) of mound densities into unsampled areas.

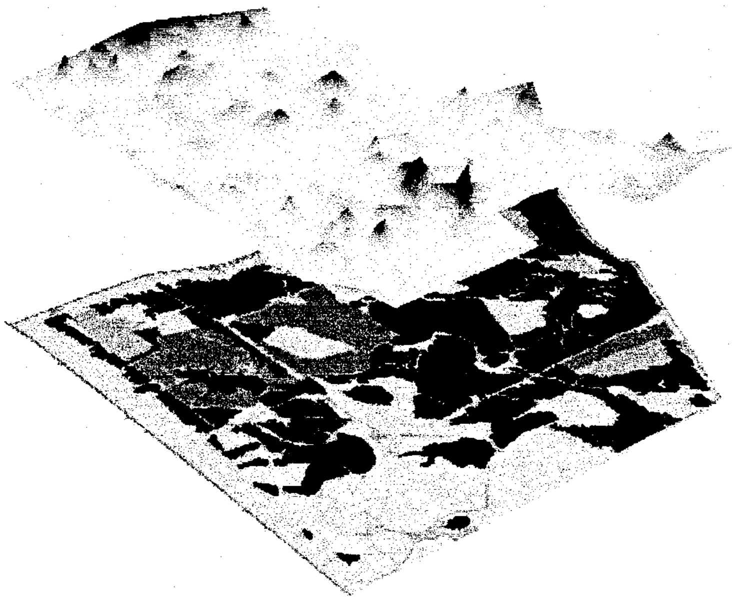

Fig. 4. 3-dimensional representation of mound densities per sample.

Temporal variation study. Thirty sample plots were chosen randomly in patch 64 (airfield) at four times: May 1998, Aug 1998, Dec 1998, and Feb 1999. The mean density of mounds for all samples were not significantly different between the May, Dec, and Feb collections, but were significantly lower in the Aug sampling (Fig. 5).

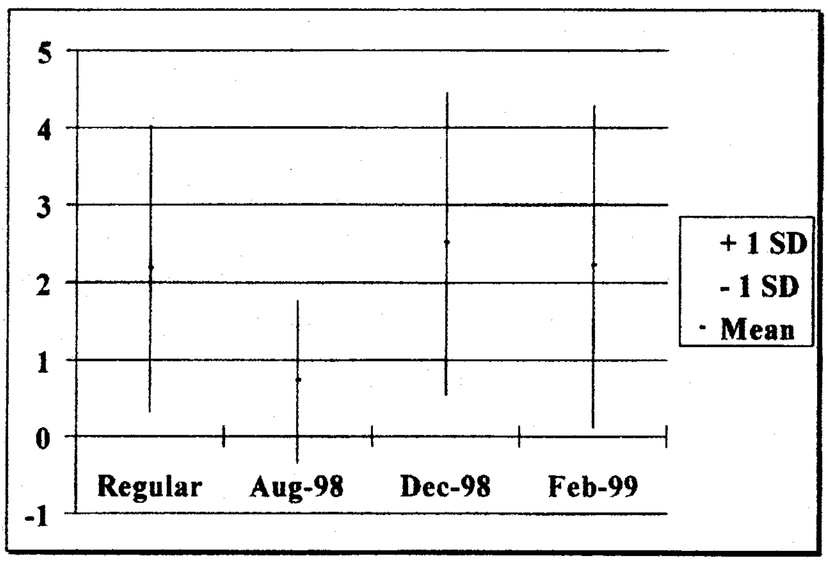

Fig. 5. Graph of average mound densities of 30 samples over 4 sampling periods.

Gyne type distribution. Samples of ants from colonies were taken throughout the study area to determine the distribution of the monogyne (single queen) and polygyne (multiple queen) forms of the red imported fire ant. Determination of gyne type was based on mean head width measurements (Greenberg et. al. 1985). The distribution of sample plots with nearest neighbor analysis of gyne type is presented in Figure 6.

Fig. 6. Sample mound density over distribution of monogyne/ polygyne distribution. Light grey = polygyne, dark grey = monogyne distribution, medium greys = unknown or intermediate gyne type distribution.

Mound densities by landscape cover type. In our initial analysis of the data, the number of mounds per sample were averaged for each landscape cover type. The average density of mounds per sample for each of the four major landscape cover types were: grassland, 3 mounds/sample; cleared woodland, 2.3 mounds/sample; woodland, 1.25 mounds/sample; and bare soil, <1 mound/sample. We were also interested in patches that had significantly more or fewer mounds than the average for each patch type (Fig. 7). Two areas of greater density were found one at the northeast edge of the study area and another at the south-central edge of the study area. Areas of less density were found to be numerous scattered patches throughout the study area. We are currently analyzing the data using standard statistical methods and spatial statistical methods.

Fig. 7. Relative densities of mounds by patch type. White = average mound densities by patch within 1 std of average for patch type, light grey = average mound densities by patch more than 1 std greater for patch type, dark grey = average mound densities by patch more than 1 std less for patch type.

Conclusions

Several tools not normally used in the study of insect ecology have been employed to study red imported fire ant distribution and abundance in a spatial context at mesoscale. Tools used include aerial photography, videography, Geographic Information Systems (GIS), and real time differential global positioning. Such technologies enabled researchers to truly randomize sample plots throughout the study area and conduct spatially referenced studies in a non-invasive manner on an actively managed resource.

Use of the landscape ecological Patch/ Corridor/ Matrix model facilitates interpretation of how red imported fire ants utilize the landscape. Red imported fire ants were observed in all landscape elements throughout the post oak savanna study site, however, considerable variation in numbers of active red imported fire ant mounds were found. Preliminary study indicates this variation is not simply a function of patch type; other potential influences include patch size, patch interface composition, and distance to water. In further analysis, the distribution and abundance of red imported fire ants will be examined with regard to content and context of landscape elements. It is likely that pattern in distribution and abundance will be understood by examining data at varying resolution and scale.

Acknowledgements

We thank Mr. Kent Moore for providing access to his ranch and the Texas Red Imported Fire Ant Initiative for providing financial support.

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Fire Ant Control with Conserve* Drench and Bait Applications

R. B. Cooper & T. C. Blewett
Dow AgroSciences

*Trademark of Dow AgroSciences

Fire Ant Control with Conserve*
1998 Research

- Program conducted throughout the Southeastern United States
- Special thanks to:
  - Johnson & Gorsuch at Clemson
  - Sparks & Diffie at UGA
  - Barr at Texas A&M
  - Collins & Callcott at USDA/ARS Gulfport
  - Unruh at UFL
  - Brandenburg & Hertl at NCSU

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Conserve* Drench Applications

- Locations: Clemson (1), UFL (1), DAS(2)
- Design: Completely random, single mound plots, 10 mounds/treatment, ELPA present all mounds at time of application
- Mound Size:
  - Small mounds: <8 inches diameter at base
  - Large mounds: >8 inches diameter at base
- Drench Concentration: 95 ppm
- Drench Applications: 0.5, 1, and 2 gallons/Mound
- Evaluation: Percent control

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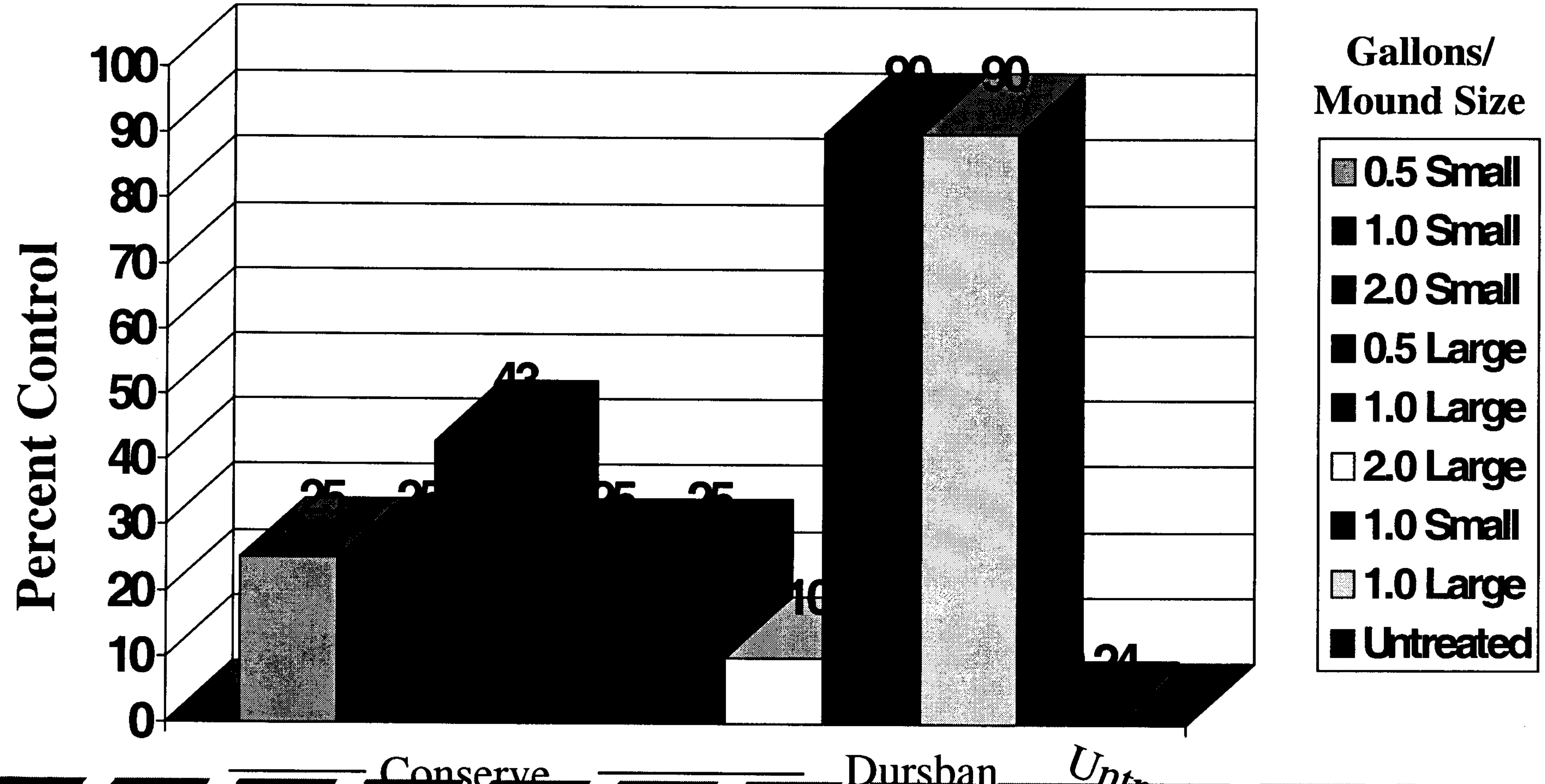
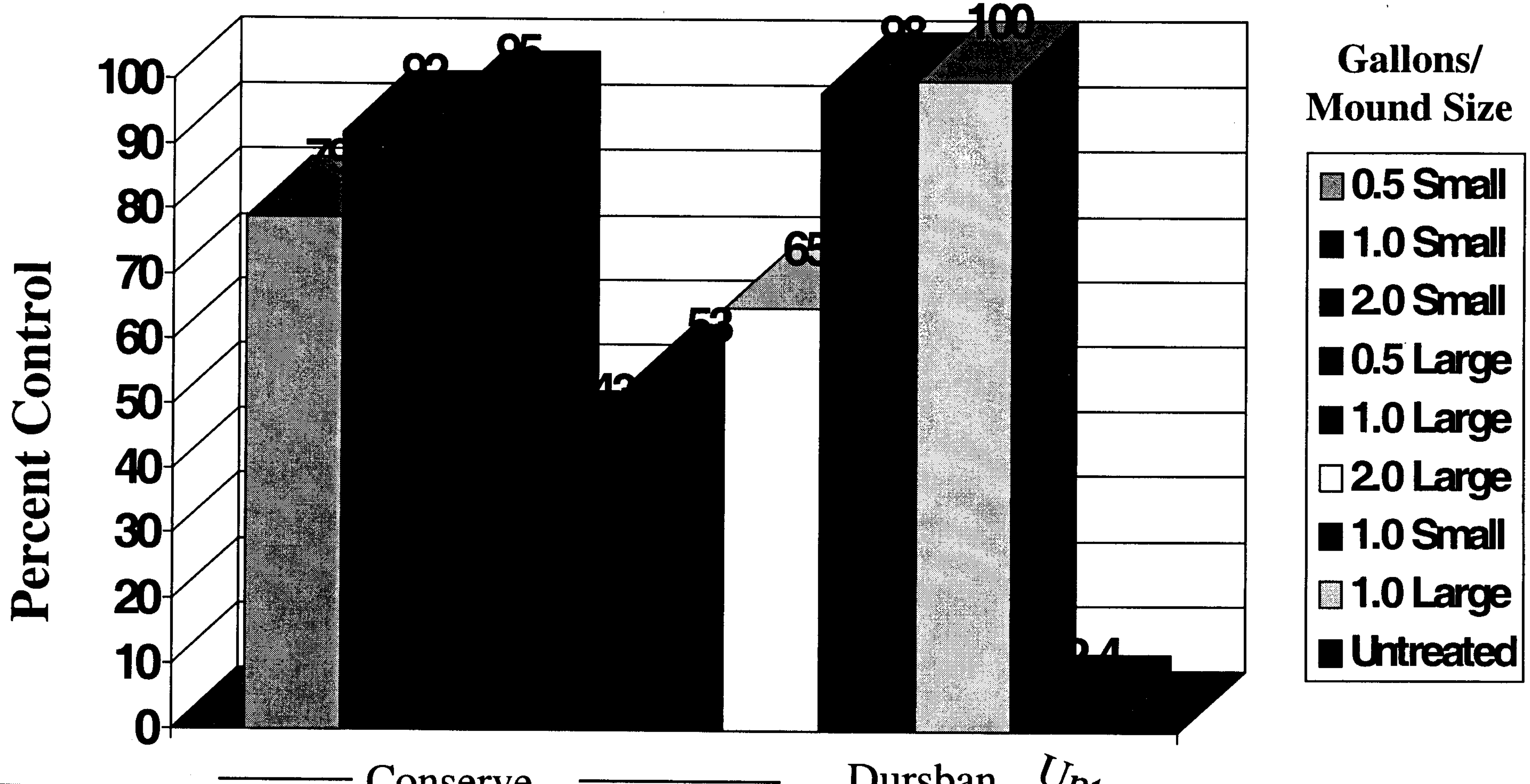
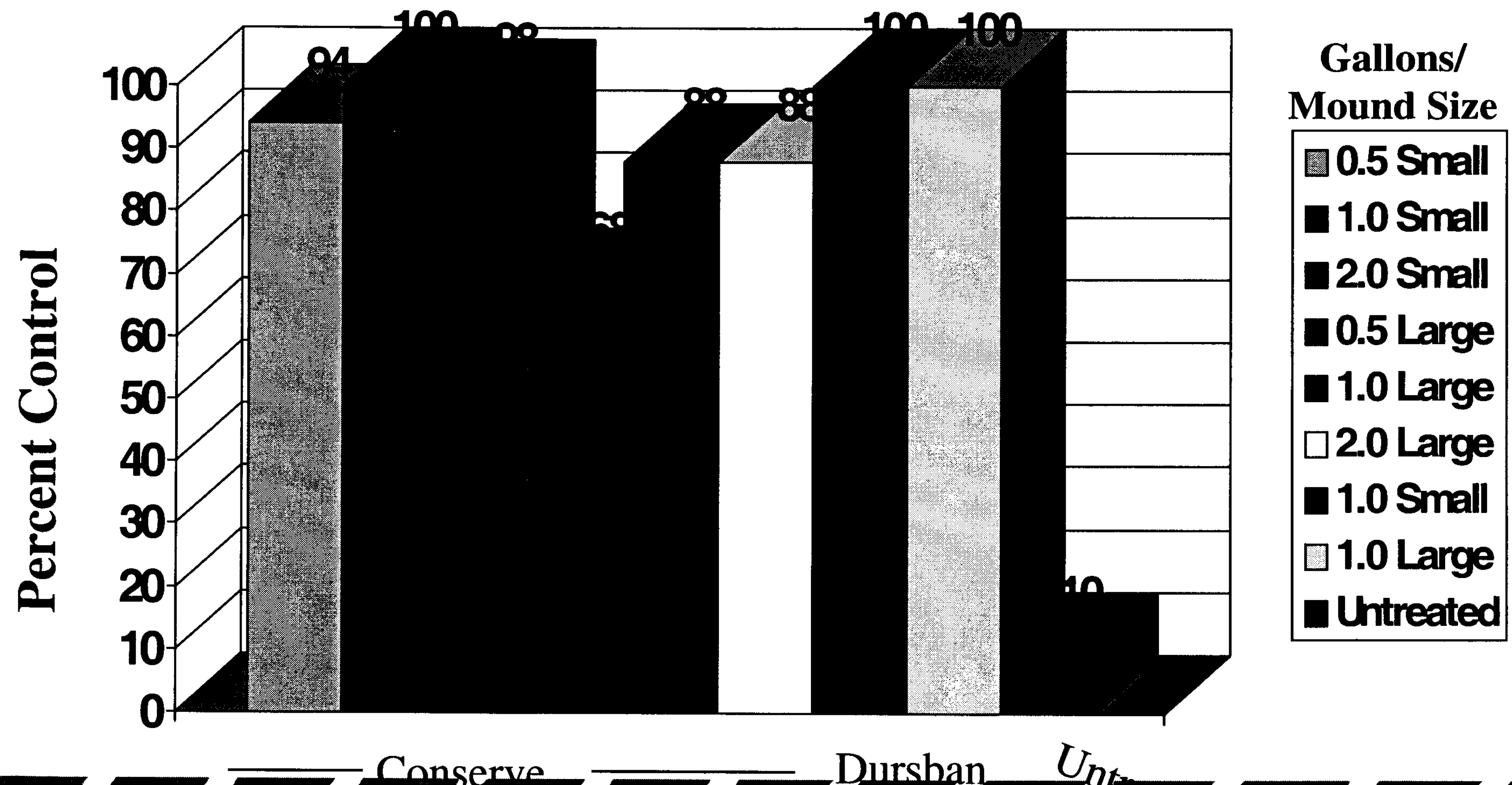
Control of RIFA with Conserve* 1SC Applied as a Drench, 4 Studies, 1998, 1DAA



Control of RIFA with Conserve* 1SC Applied as a Drench, 4 Studies, 1998, 7DAA



Control of RIFA with Conserve* 1SC Applied as a Drench, 4 Studies, 1998, 15DAA



Conserve* Drench Applications

Summary & Conclusions

- All Conserve treatments gave poor RIFA control 1DAA, while Dursban provided good control
- Conserve at 1 and 2 gallons/mound gave acceptable control of small mounds 7DAA. Control of large mounds was poor at all volumes
- By 15DAA, all Conserve volumes gave acceptable control of small mounds, with 1 and 2 gallons effective against large mounds

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Conserve* Drench Applications STATUS

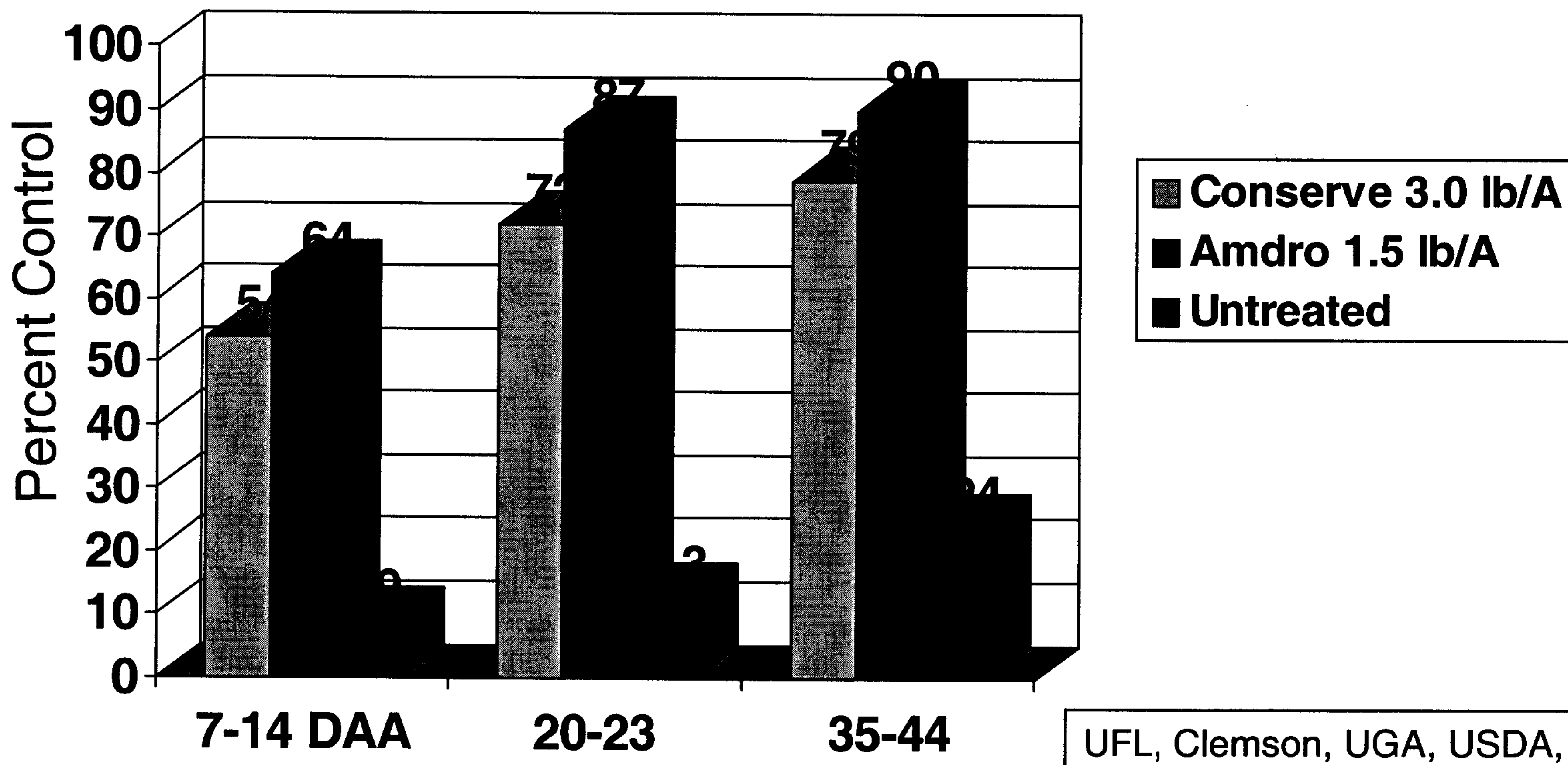
- Drench application has been added to the current label
- Rate: 95 ppm (0.1 fl oz/gallon)
- Volume: Mounds <8"=1 gallons

  Mounds >8"=2 gallons
- Directions: Apply 90% directly onto mound, 10% out about 12"
- Fit: Low toxicity biorational control

Conserve* Bait Broadcast Applications

- Locations: UGA (1), UFL (1), Clemson (1), TAMU (1), USDA (1), DAS(2)
- Design: Randomized complete block, 3 replications, 1 acre plots, ELPA present all mounds at application
- Evaluations: Percent control (0-100%) of all mounds within center 1/4 acre of each plot
- Weather: Hot, dry conditions prevailed at 4 of 7 test sites at and after application

Control of Fire Ants with Conserve* 0.015% Bait Applied Broadcast



UFL, Clemson, UGA, USDA, [redacted]

[redacted]

Conserve* Bait Broadcast Applications
Summary & Conclusions

- Conserve 0.015% bait applied at 3.0 lb product/A provided 79% control vs. 90% control with Amdro 35-44 DAA
- Considerable mound loss, 24%, was evident in untreated areas 35-44 DAA
- Additional fall trials (not reported) indicate that Conserve broadcast at 5 lb product/A provides increased control

*Trademark of Dow AgroSciences

Conserve* Broadcast Applications
STATUS

- 1999 research effort further characterizing rate range
- Other formulations will be evaluated
- Initial emphasis will be professional market
- Expect to submit for registration in 1999
- Fit: Reduced risk, biorational control

Conserve* Bait Applied to Individual Mounds

- Locations: UGA (1), NCSU (1), Clemson (3), UFL (1), USDA/ARS (1), DAS (9)
- Design: Most trials completely random, single mound plots, 10 mounds per treatment, ELPA present all mounds at application
- Evaluations: Percent Control (0-100%)

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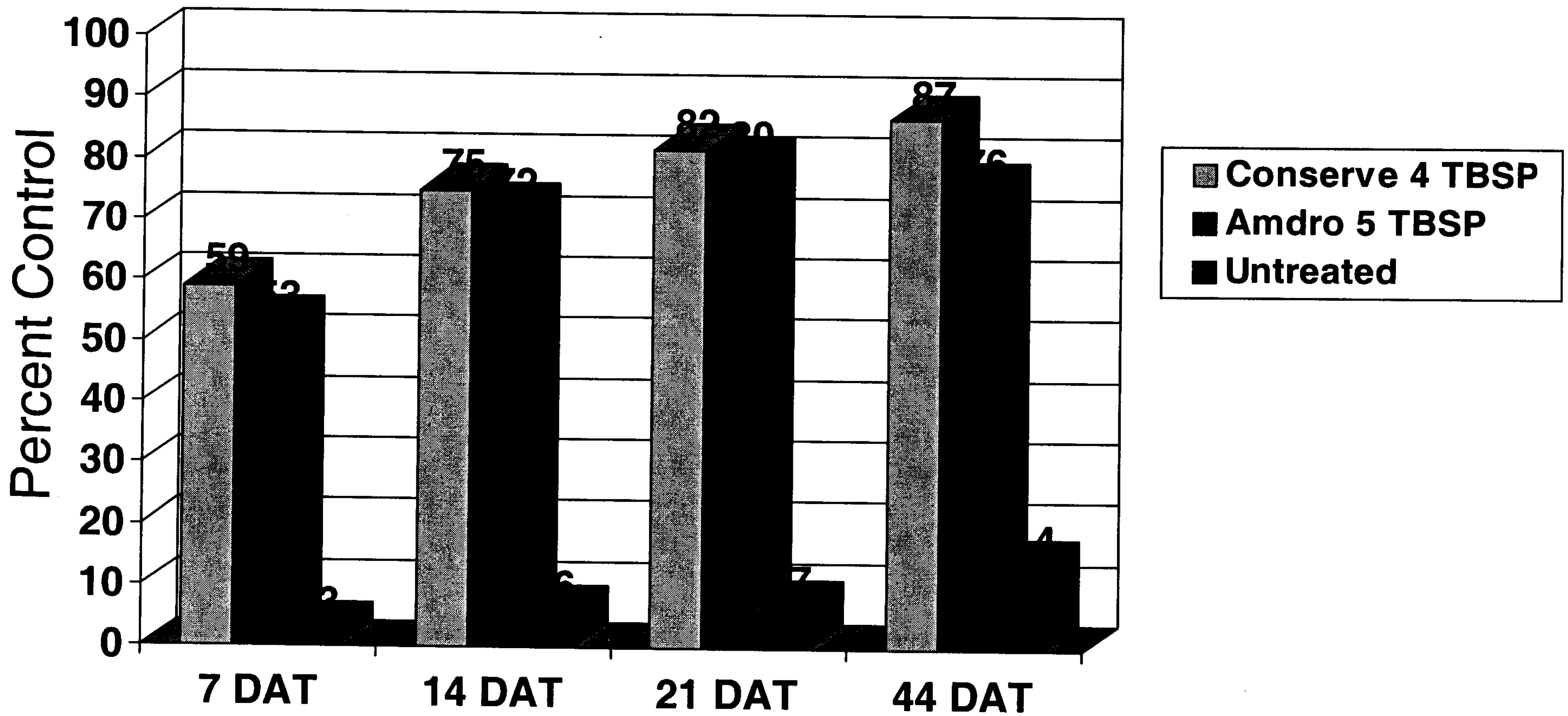
Control of Fire Ants with Conserve*
0.015% Bait Applied to Individual Mounds



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Conserve* Bait on Individual Mounds

Summary & Conclusions

- Evidence of activity with Conserve bait was observed in 7 days or less after application
- Conserve provided 75% control within 14 DAA increasing to 87% control 44 DAA
- Conserve gave slightly greater control than Amdro at all observation times
- All treatments provided poorer control compared to 1997, possibly due to extreme heat and drought

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Conserve* Bait on Individual Mounds

STATUS

- Label for Conserve 0.015% bait approved by EPA in 1998
- Rate: 4 tablespoons/mound
  1/2 to 3/4 cup per 1000 sq. ft.
- Target retail homeowner market
- Will be sold by major retail supplier
- Available on retail shelf late summer, 1999
- Formulation development efforts will continue
- Provides low-toxicity, biorational control option

*Trademark of Dow AgroSciences

Development of cell lines of the imported red fire ants for the mass production of parasites

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The imported red fire ants are a serious pest in United States and they are now distributed all over the Southern area. Many different approaches to control this pest are being under investigation, and the discovery of parasites infecting this ant is been promoted as one of the most promising biological approach to suppress the fire ants population in the US territory. Thelohania, a cell obligate parasite that infects different tissues of the fire ants, is one of the most important parasites under investigation. However, the practical use of this biological control agent is dependent of the development of mass rearing techniques. *In vitro* rearing systems where cells lines are used to produce this cell parasite would make its mass production economically feasible since the production on live hosts would be extremely expensive and labor intensive. We describe the basic studies to chemically characterize the hemolymph of the fire ants for the development of an artificial cell medium for the establishment of cell lines of the fire ants, as well as the use of available commercial media in our studies. Cells from all different tissues (fat body, ovaries, testis, venom gland and hemocytes) survived for a long time in all cell media tested, but cell growth was poorly achieved. However, it was possible to keep for 3-5 sub-cultures of cells from the fat body and ovaries and a prohemocyte-like cell in a medium based on the composition of the fire ant hemolymph. Research is still in progress to enhance the cell growth through the use of cell media supplements.

The effects of removing red imported fire ants on the growth, foraging, and survival of northern bobwhite chicks on the Welder Wildlife Refuge of South Texas

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Introduction

Red imported fire ants (RIFA) (*Solenopsis invicta* Buren) are an invasive non-indigenous species introduced into the United States that has had strong negative impacts on native ecosystems. RIFA are native to the Pantanal of Brazil, in the state of Mato Grosso. They also occur outside the Pantanal region, in the Brazilian states of Rondonia, Goias, Minas Gerias, and Sao Paulo, particularly in cerrado vegetation and disturbed areas (Fowler et al. 1990). They were accidentally introduced into the United States in the 1930's around Mobile, Alabama (Hung and Vinson 1978) and have expanded throughout the southern states. They arrived in Texas by 1953 and have spread south and west at a rate of approximately 50 km per year (Hung and Vinson 1978). Imported fire ants are now present in the eastern two-thirds of the state.

RIFA are in many ways typical of successful invading species (Ehrlich 1986). They prefer anthropogenically disturbed habitats (Tschinkel 1988), they tolerate a relatively wide range of climatic conditions, and they are opportunistic omnivores (Vinson and Greenberg 1986). They have a high reproductive capability that results in rapid colony growth (Porter 1988) and have the potential to produce thousands of reproductive individuals each year (Vinson and Greenberg 1986). Despite their high intrinsic rate of growth, their numbers are apparently regulated by competitors in their native range (Fowler et al. 1990). In South America, RIFA populations are controlled by some 40 to 50 species of predators, competitors, and pathogens (Porter at al. 1997). In the United States, only 2 or **3** natural enemies of RIFA have been found (Porter at al. 1997). As a result, RIFA are more abundant throughout their introduced range than within their native habitats. Mound densities are approximately 10 times greater in the southeastern U.S than in Brazil (Porter et al. 1997).

In most of their native and much of their introduced range, RIFA occur in monogynous colonies where there is one fertile queen, and the colonies are highly territorial. In the southeastern U. S., monogyne RIFA mound densities are generally <100 mounds/ha, which is comparable to densities found in Brazil in severely disturbed cerrado, such as roadsides (Wojcik 1986). In some parts of their introduced range, RIFA occur in polygynous colonies, where multiple fertile queens are present in the nest mound and territoriality among colonies is reduced or absent. The polygynous form is more prevalent in Texas than in other areas of its introduced range (Porter et al. 1991). Polygyne colonies of RIFA can reach densities as high as 22000 mounds/ha (Porter et al. 1991). Polygyne RIFA recruit roughly twice as many workers to bait as the monogyne form (MacKay et al. 1994). Mean worker mass in polygyne colonies is considerably less than for monogyne colonies (Goodisman and Ross 1996). Despite differences in worker size, polygyne RIFA population densities (number of foraging workers, total number of individuals, and total colony biomass) are approximately twice that of monogyne RIFA (Macom and Porter

1996). Individual polygyne colonies may occupy multiple mounds; the result is that numerous colonies can completely cover fields and consume most of the available resources (Macom and Porter 1996). RIFA replace many other native ant species, including native *Solenopsis* species, and exclude nearly all other ant species in infested areas (Porter and Savignano 1990).

The introduction of RIFA has negatively affected agricultural and ecological communities. In urban locales, RIFA have caused human medical problems and damaged electrical and industrial equipment. In agricultural settings, RIFA have damaged crops, farm equipment, and caused livestock mortality. RIFA have also been linked to a number of problems with ecological systems and wildlife species (Vinson 1997, Allen et al. 1998).

RIFA have negatively impacted many vertebrate species (Allen et al. 1998). Researchers have demonstrated that pipping chicks and altricial young are most vulnerable to RIFA predation (Allen et al. 1998). For newborn mammals, it has been reported that RIFA preyed on captive eastern cottontail rabbits (*Sylvilagus floridanus*), killing between 16% and 50% of litters in different sized enclosures (Hill, 1969). In other investigations, *S. invicta* is also believed to have killed northern pygmy mice (*Baiomys taylori*) (Killion et al. 1995) and white-footed mice (*Peromyscus leucopus*) (Masser and Grant 1986). Among birds, predation by RIFA has been observed on crested caracara nestlings (*Caracara plancus*) (Dickinson 1995), cliff swallow nestlings (*Hirundo pyrrhonota*) (Sikes and Arnold 1986), Mississippi kite (*Ictinia mississippiensis*) (Parker, 1977) and wood ducks (*Aix sponsa*) (Ridlehuber 1982). Drees (1994) found that nest mortality of colonial nesting waterbirds was nearly 100 percent on infested Gulf coastal barrier islands. There is a negative relationship between date of RIFA infestation and loggerhead shrike (*Lanius ludovicianus*) abundance (Lymn and Temple 1991).

The northern bobwhite (*Colinus virginianus*) is a popular game bird that has decreased in abundance over much of its range, particularly in the last three decades. Several factors have contributed to this decline. In the South, northern bobwhite prefer "weedy corners of cornfields next to a tangle of blackberry briars, cane, cat briars, and brush, into which they can retreat at a moments notice" (Bent 1932). Such brushy habitat provides an abundant food supply of weed seeds and crucial nesting and escape cover. Bobwhite probably increased in abundance and distribution as land was cleared for farming across the eastern half of the United States. Changes in agricultural and silvicultural practices, particularly in the postwar period, likely had an adverse effect on bobwhite populations. Modern farming methods have resulted in larger farms and cleaner fields. Plant and invertebrate species that are undesired from the agricultural perspective are reduced in these "cleaner" fields. This, in turn, has reduced food supplies, nesting habitat, brood-rearing cover, and escape cover for bobwhites (Brennan 1991). Likewise, many abandoned farms have been converted to pine plantations (Brennan 1991). In such abandoned locales, undisturbed plant succession makes habitat unsuitable for quail in five to ten years (Stoddard 1931). After canopy closure, important quail food plants, which are typically annual weeds, are absent (Rosene 1969).

In addition to changes in land use, predators also impact bobwhite nesting success and survival. In north central Missouri, Burger et al. (1995) found that predation accounted for 55% of observed annual mortality split about evenly between birds and mammals. On the Packsaddle WMA, OK, DeMaso et al. (1997) found that predation by mammals (28%) and birds (37%) accounted for 65% of the average monthly mortality. The non-indigenous fire ant in the southern United States is another predator on bobwhite.

Reports of fire ant predation (although most likely the native *Solenopsis geminata*) on northern bobwhite chicks date back to the 1930's (Travis 1938). There is a negative relationship between date of RIFA infestation and northern bobwhite (*Colinus virginianus*) abundance (Allen et al 1995). Allen et al. (1995) found that large-scale experimental removal of RIFA resulted in increased densities of both northern bobwhite and loggerhead shrikes. Giuliano et al. (1996) showed that growth and survival of bobwhite chicks was reduced by exposure to RIFA stinging. Pederson et al. (1996) found that RIFA altered bobwhite chick behavior, resulting in reduced foraging. Because of this previous work, we designed experiments to test: (1) removal of red imported fire ants affects bobwhite chick foraging behavior; (2) removal of RIFA increases bobwhite chick growth; (3) removal of RIFA has increases bobwhite chick survival; and (4) removal of RIFA has increases invertebrate biomass and abundance.

Study Area

We conducted our experiments on the Rob and Bessie Welder Wildlife Refuge in San Patricio County, Texas in April through July in 1997 and 1998. The Welder Refuge is located in a transitional zone between the Gulf Prairies and Marshes and the South Texas Plains (Drawe et al. 1978). Climate is humid subtropical (Box et al. 1978) with an annual mean temperature of about 22°C (Rappole and Blacklock 1985) and a mean growing season of about 300 days (Drawe et al. 1978). Long-term average precipitation in the nearby communities of Woodsboro and Sinton, Texas is about 90cm/yr. However, annual precipitation fluctuates widely, ranging from 38.0 cm in 1956 to 125.1 cm in 1973 (Drawe et al. 1978). In the Texas Coastal Bend region, evapotranspiration normally exceeds precipitation by about 35 cm per year (Drawe et al. 1978). Vegetation on the refuge is characterized as a mixed mesquite (*Prosopis glandulosa*) live oak (*Quercus virginiana*) shrubland, interspersed with areas of coastal prairie grassland (Box et al. 1978).

We selected three sites in 1997 of approximately 4 ha each on unimproved native pasture. All of the sites were located in bunchgrass-annual forb communities on Odem fine sandy-loam soils (Drawe et al. 1978) with an interspersion of mixed brush species, predominately honey mesquite. We added a fourth site in 1998.

Methods

We divided each of the 4 ha sites into approximately equal treatment-control pairs and randomly assigned AMDRO (American Cyanamid) treatment to remove RIFA. Prior to treatment, we sampled RIFA foraging and found no differences ($P>0.50$) between the designated treatment and control sites. We applied AMDRO on the treatment sites using an ATV-mounted spreader (Herd GT-77ATV) at the recommended rate of 1.67 kg/ha during the third week of April in both 1997 and 1998. In the interior of each of the sites, we erected circular enclosures of approximately 3 m^2 constructed of hardware cloth.

We obtained day-old northern bobwhite chicks from a commercial breeder (Stevenson's Gamebird Farm, Riverside, Texas) and randomly assigned birds to each treatment group and site. We housed the chicks under heat lamps in pens constructed of wood and hardware cloth. We allowed the chicks *ad libitum* access to commercial gamebird feed (Nutrena Turkey and Gamebird starter, min. 28% crude protein) and water. After allowing for overnight acclimatization, we banded two-day-old chicks with individually numbered aluminum leg bands and weighed the birds on a digital balance

(Ohaus SC2020-2A0, 200g x 0.01g) to obtain pre-trial weights. We used a digital thermometer (Barnant Co. Type K thermocouple Model 600-1010) to record air temperature at one meter and soil temperature at 5cm. In 1998, we also recorded surface temperature and soil temperature at 2 cm.

RIFA mound density estimation and foraging. We estimated mound density by performing line transect counts on each of the sites during the first week of April 1998 (Buckland et al. 1993). We conducted a pilot study on the sites to determine the distance necessary to ascertain the fire ant mound encounter rate. Using the encounter rate estimate obtained during the pilot study, we calculated a transect length (300m) that would result in a density estimate with a coefficient of variation of <0.2. We only included active mounds during our counts. We determined whether the mound was active by physical disturbance of the mound. We measured perpendicular distance to the center of each mound. We calculated RIFA mound densities using the density estimator program DISTANCE (Laake, et al. 1996) and selected models with the lowest Akaike Information Criteria (AIC). We assigned a mound density value of zero to AMDRO-treated sites.

We measured foraging worker recruitment to bait, which is an established technique for estimating fire ant foraging activity and relative density (Porter et al. 1991, Porter et al. 1987, Wojcik 1983). We sampled RIFA foraging activity by placing 5 round clear containers (50 mm in height x 30 mm diameter base) baited with small (approximately 1cm^3) frankfurter pieces on the ground over a 20 m distance at 5 m intervals. We allowed the worker ants to forage on the baits for 20 minutes. We sampled RIFA foraging between 07:00 and 12:00 over three 9-day experimental trials in June and July 1997 and five 8-day trials in May to July 1998. After the foraging trials, we counted the number of ants captured and used the cumulative number of ants captured per trial as a RIFA foraging index. We analyzed the correlation between imported fire ant foraging and mound density using t-tests (Sokal and Rohlf 1995).

Effects of RIFA removal on chick foraging. We conducted 8-day foraging experiments, beginning each of the experiments with 15 individuals in each group. We randomly selected groups of birds and transported groups to field sites at sunrise. Following transport, we sampled chick foraging for each of the sites. We estimated chick foraging by counting the number of food strike attempts made by two randomly selected focal individuals over two 15-minute periods and used the mean of the two trials as a foraging index. Following the final foraging trials, we retrieved the groups from the field. All of the chicks were exposed to field conditions in the enclosures for between 5 and 6 hours/day. We investigated the relationship between removal of imported fire ants and chick foraging using analysis of covariance with RIFA removal as the factor and chick age as the covariate. We chose an $\alpha=0.05$ to assign significance of results of effects of the removal of imported fire ants on bobwhite chick foraging.

Effects of RIFA removal on chick survival. We calculated a Kaplan-Meier survival estimate for the 8-day trial intervals (Bunck et al. 1995). We compared survival rates for treatments and controls using the program CONTRAST (Hines and Sauer 1989). We performed an arcsine transformation (Sokal and Rohlf 1995) on the survival estimates to normalize the survival data. We analyzed the correlation of survival and fire ant indices and the effects of chick growth on survival (Draper and Smith 1998). Because there was a positive correlation between the means and variances of RIFA mound density and RIFA foraging activity, we log-transformed these variables to stabilize variance prior to regression analysis (Sokal and Rohlf 1995). We chose an

$\alpha=0.05$ to assign significance of results of effects of the removal of imported fire ants on bobwhite chick survival.

Effects of RIFA removal on chick growth. We weighed each of the birds daily to assess growth prior to returning the chicks to their pens following the foraging trials and calculated mean daily growth for the trial period. For the 1998 trials, we recorded the ambient temperature immediately following the placement of each group of chicks in their enclosures. After retrieval of each group of birds we recorded the ambient temperature. We computed a mean trial temperature by calculating the average of these starting and ending temperatures. We explored the effect of removing RIFA on chick growth using analysis of variance (ANOVA). We examined the relationship between chick growth and fire ant recruitment to bait using regression analysis. We also investigated the relationships between removal of RIFA, julian month in which the experiments occurred, and temperature using ANOVA for the 1997 data and regression analysis for the 1998 data. We also investigated the relationship between chick growth and survival by calculating a correlation between these two factors and then using t-tests (Sokal and Rohlf 1995). We chose an $\alpha=0.05$ to assign significance of results of effects of the removal of imported fire ants on bobwhite chick growth.

Effect of RIFA removal on invertebrate abundance. In 1998, we sampled terrestrial invertebrate abundance and diversity by pitfall trap (Greenslade 1964) and sweepnet sampling (Southwood 1978). On the interior of each of the sites, we buried eight 750-ml polyethylene containers level with the ground arranged in a 20m x 20m square, so that there were 3 traps on each side of the square located approximately 10m apart. On each diagonal, we placed 4 additional containers 10m in from each of the corners, for a total of 12 pitfall traps/site (Figure 1). We placed a second container into each of the buried traps and added approximately 25ml of a 1:1 ethylene glycol: water solution to capture and preserve invertebrate samples. We closed pitfall traps with a tight-fitting lid when not in use. We conducted pitfall sampling for approximately 24 hr for each sampling effort.

We collected invertebrates in herbaceous vegetation using sweepnet sampling using 50 "sweeps" for each sampling effort. We conducted the sweepnet sampling in the interior (≥30m from the boundary) of each of the study plots. We transferred the invertebrate samples from the sweepnet into a 0.95 liter collecting jar (BioQuip 1121C) containing a small quantity of ethyl acetate to kill the invertebrates. We coordinated the invertebrate sampling so that 4 pitfall samples and 4 sweepnet samples were taken at each site for every 8-day chick foraging trial. After each of the sampling efforts, we estimated the biomass of the sample using volumetric displacement of ethanol. We used this displacement volume as an index of invertebrate biomass. We also identified the invertebrate samples to the taxonomic level of Order and quantified the number of each of these sampled taxonomic groups. We analyzed the effects of RIFA removal on invertebrate biomass and abundance within each of the taxonomic groups using Mann-Whitney U-tests, and selected $\alpha=0.10$ to assign significance.

Results

RIFA mound density estimation and foraging. We used the half-normal and hazard rate models to estimate mound density because they consistently minimized AIC values. Our mound density estimates for untreated sites in 1998 ranged from 231 to 1339 mounds/ha. We recorded an average of 327.02 foraging workers per trial (SE=29.747, N=227 trials) on control sites and 5.4 foraging workers (SE=1.131, N=234 trials) on treated sites. The imported fire ant foraging index was correlated with mound density on the control sites ($r=0.732$, $t=17.43$, 152 df, $P<0.001$).

Effects of RIFA removal on chick foraging. Because there was a difference in variance of food strike attempts between the first day of experiments and subsequent days ($P<0.001$), we omitted foraging data from day 1 in our analysis. Although birds from control sites made approximately 20% more food strike attempts than birds from RIFA-removal sites, we found no effect of RIFA removal on chick foraging ($P=0.113$) when chick age was analyzed as a covariate.

Effects of RIFA removal on chick survival. We found no difference in survival rates for the treatment ($P= 0.22$) or control ($P= 0.06$) groups between years, so we combined years. Removal of imported fire ants had an effect on chick survival ($P= 0.005$). Chick survival declined as imported fire ant mound density ($r=-0.752$; $t=6.939$; $df=37$; $P<0.001$) and RIFA recruitment to bait increased ($r=-0.744$, $t=6.773$; $df=37$; $P<0.001$) in 1998.

Effects of.RIFA removal on chick growth. Because there was a clear handling effect on the mass gain of the birds on the initial day of the trial, we calculated the mean growth rate as the average from day 2 through day 8 of the trial. There was no difference in growth rates for the treatment ($P= 0.29$) or control ($P= 0.13$) groups between years, so we combined years and found that removal of RIFA increased chick growth ($P< 0.002$).

Average daily temperatures (°C) for May-July at the Welder Refuge were 27.0 in 1997 and 28.8 in 1998, and average daily rainfall for this period was 2.6 mm in 1997 and 0.3 mm in 1998. In 1997 and over both years, there was a effect of month ($P<0.001$) and RIFA removal ($P<0.001$) on growth). In 1998, ambient trial temperature and RIFA recruitment to bait were significant predictors of chick growth, resulting in the equation *Mean Chick Growth (g/d)* = - 0.152 + 0.0582 *MeanTrialTemp (°C)* - 0.0355 *logRIFA* ($R^2=0.328$; $F=6.82$; $df=2,28$; $P=0.004$). In addition, we found that mean chick growth is a predictor of chick survival, resulting in the equation *arcsin Survival* = - 0.175 + 0.886 *Growth (g/d)*($R^2=0.212$; $F=12.13$; $df=1,45$; $P=0.001$).

Effect of RIFA removal on invertebrate abundance. Removing RIFA increased invertebrate biomass indices for pitfall samples ($P=0.080$) and sweepnet samples ($P=0.098$). We also found differences in abundance for most invertebrate groups collected using pitfall sampling (Table 1), and sweepnet sampling (Table 2).

Discussion

Imported fire ants are a novel threat to bobwhite and other native fauna, having arrived in the Texas Coastal Bend only in the mid-1970s. The USDA quarantined San Patricio County for imported fire ants in 1975 (Calcott and Collins 1996), and by 1980, RIFA were a noticeable nuisance on the Welder Refuge (Drawe, pers. comm.). Recent investigations have shown that imported fire ants negatively effect bobwhite foraging behavior (Pedersen et al. 1996), growth (Giuliano et al. 1996), survival (Giuliano et al. 1996), and population density (Allen et al. 1995).

One possible explanation for our finding of no difference in foraging rate may be that the birds were less selective in their foraging and were also attempting to forage on nonfood items. A more likely explanation might be that, on the control sites, "food strike attempts" might not only reflect foraging attempts, but also chick defense against fire ant workers. We directly observed quail chicks pecking at RIFA on the site with the highest measured RIFA activity and density. However, we found no difference between the foraging indices for all four control sites and the remaining three sites when this site (Venado) was removed from the analysis ($P=0.338$). We also observed chicks "avoiding" (i.e., running away from) both imported fire ants and red harvester ants (*Pogonomyrmex barbatus*) in the enclosures.

In 1998 on the Venado site, the site with the highest RIFA mound density and foraging indices, we observed experimental birds killed by fire ants. Despite relocating the experimental enclosure on this site following the initial RIFA depredation of chicks, additional birds placed at this site were subsequently killed by fire ants. In 1997, we did not observe direct mortality on the Venado site or elsewhere. We believe that there was some difference in fire ant foraging behavior in 1998. We observed that there was no difference in RIFA foraging indices between years. The period of May-July 1998 was warmer and drier than the same period in 1997. In 1997, the mean daily temperature at the Welder Refuge was 27.0°C, whereas in 1998 it was 28.8°C. For the three-month period in 1997, the Refuge received 235mm of rainfall, but only 24mm in 1998. The drought conditions in 1998 may have altered RIFA behavior in some way so that they became more 'aggressive.'

We found evidence of a negative effect of imported fire ants on the survival of bobwhite chicks. RIFA may reduce survival either directly through predation or indirectly through envenomization or malnutrition. Giuliano et al. (1996) found that newly hatched bobwhite exposed to large numbers of fire ant stings in the laboratory had increased mortality. IFA may also indirectly affect chick survival through reducing chick growth and increased risk to disease and predation. We found a correlation between growth and survival, suggesting that there may be an important link between them. A reduction in growth rate might result in a lower overall fitness, and might make smaller birds less able to handle the stresses of thermoregulation and experimental handling.

Imported fire ants also had an effect on the growth of bobwhite chicks. Based on similar results in Giuliano et al. (1996), we suspect that this might be due in part to a physiological response to envenomization from the ants. Pedersen (1996) also suggests that a result such as this might be due to a difference in chick behavior in response to fire ants, resulting in less time devoted to foraging. As previously noted, we found no evidence for this mechanism, although it might still be a factor in the observed difference in growth rates. Allen (1993) found that removal of IFA resulted in an increase in invertebrate biomass, and this may reflect an increase in available food items for young bobwhite quail.

Removal of fire ants increased the biomass and abundance of invertebrates on our study sites. This observation is consistent with the hypothesis that RIFA negatively affect chick growth indirectly through a reduction in potential food items. Hurst (1972) found that small insects are the most important food items of bobwhite chicks and that several invertebrate groups comprised the majority of chick food items. In decreasing order of importance, they were beetles (Coleoptera), leafhoppers (Homoptera), true bugs (Hemiptera), spiders (Araneae), grasshoppers (Orthoptera), ants (Formicidae), larvae of Hymenoptera and Coleoptera, snails, and flies (Diptera). An earlier investigation by Handley (1931) yielded similar results, with Coleoptera comprising about 32 percent, Orthoptera making up about 27 percent, Aranae about 8 percent, caterpillars and moths another 8 percent, "bugs' about 7 percent, and "miscellaneous insects" about 2 percent of foods eaten. We found greater numbers of nearly all of these invertebrate groups after removal of fire ants, suggesting that there was a greater availability of food items to bobwhite chicks.

Since imported fire ants have arrived in South Texas, a number of vertebrate species have shown population declines (Allen 1993). Although imported fire ants have a negative effect on vertebrate species, such as bobwhite quail, populations of these vertebrates continue to coexist in areas where fire ants are established. This raises an interesting question, namely, how these species are able to minimize their risk to fire ants. We observed that there is a high degree of heterogeneity in fire ant distribution on the landscape. One can speculate that vertebrate species might minimize their risk by selecting nesting and brood rearing habitat in areas of lower RIFA densities.

On our Welder Refuge study sites, for example, we observed the highest number of whistling male bobwhites on the Venado site. We observed females with broods on other sites on the refuge, but we did not observe broods on the Venado site. This site had the highest proportion of overhead brush cover (approximately 20%) of all of our study areas. It also had an imported fire ant mound density and measured ant foraging activity of at least 3 times that of the other sites. We suggest that females may avoid areas with higher RIFA densities in selecting potential nesting and brood rearing areas, whereas males may use vegetative structure as cues to select whistling posts to display to females. Anecdotal evidence suggests that captive females are able to defend broods from moderate levels of fire ant activities and only abandon nests at higher levels of RIFA disturbance (Mitchell 1988). Female avoidance of high fire ant densities would be consistent with these observations and provide evidence of an adaptive behavioral response to the presence of imported fire ants on the landscape. To date, there has been little, if any investigation as to how bobwhite and other ground-nesting birds select nest sites with respect to fire ant distribution. Such investigation would provide valuable insight into the impact of fire ants on ecosystems at the landscape scale.

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Table 1. Effect of RIFA removal on abundance of individual invertebrates collected using pitfall sampling (N=80) from May-July 1998 on the Welder Wildlife Refuge, Sinton, Texas.

Taxonomic group	Treatment Mean (SE)	Control Mean (SE)	P
Araneae	14.31 (1.008)	20.92 (4.139)	0.215
Diptera	7.438 (0.483)	5.850 (0.441)	0.011
Orthoptera	1.800 (0.229)	1.625 (0.168)	0.482
Hemiptera	1.563 (0.185)	0.538 (0.096)	<0.001
Homoptera	20.29 (1.390)	15.10 (1.051)	0.004
Coleoptera	10.89 (0.654)	7.825 (0.590)	<0.001
Hymenoptera	13.25 (0.919)	8.213 (0.690)	<0.001
Odonata	0.075 (0.030)	0.063 (0.027)	0.382
Collembolla	46.31 (4.034)	39.14 (3.815)	0.096
Larval forms	0.913 (0.156)	0.325 (0.075)	<0.001
Snail	0.050 (0.025)	0.075 (0.030)	0.738
Isopoda	2.113 (0.426)	0.425 (0.138)	<0.001

Table 2. Effect of RIFA removal on abundance of individual invertebrates collected using sweepnet sampling (N=80) from May-July 1998 on the Welder Wildlife Refuge, Sinton, Texas.

Taxonomic group	Treatment Mean (SE)	Control Mean (SE)	P
Araneae	24.90 (2.444)	21.18 (1.919)	0.216
Diptera	11.86 (1.337)	10.43 (1.512)	0.074
Orthoptera	12.20 (1.386)	8.350 (1.141)	0.001
Hemiptera	12.01 (1.594)	7.388 (1.093)	0.002
Homoptera	57.21 (5.838)	45.96 (4.758)	0.055
Coleoptera	15.35 (1.020)	8.125 (0.666)	<0.001
Hymenoptera	3.800 (0.496)	2.563 (0.373)	0.030
Odonata	0.200 (0.052)	0.275 (0.075)	0.562
Larval forms	0.788 (0.153)	0.788 (0.250)	0.001
Snail	0.988 (0.279)	2.263 (0.415)	0.999

The Effect of Red Imported Fire Ants on *Gopherus polyphemus* at Camp Shelby, MS: Some Preliminary Results

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Introduction

Camp Shelby Training Site (CSTS) in southern Mississippi contains the largest metapopulation of gopher tortoises (*Gopherus polyphemus*) in the western portion of their range (Jennings and Fritts, 1983; Lohoefener and Lohmeier, 1984). The gopher tortoise is listed as a Threatened species by the United States Fish and Wildlife Service in Mississippi, Louisiana, and Alabama west of the Mobile and Tombigbee rivers. In addition to a federal listing, the State of Mississippi has designated the gopher tortoise as an endangered species.

The gopher tortoise has been declining in numbers throughout much of its range (Auffenberg and Franz, 1982). Notable reasons for this decline include loss of habitat, lack of recruitment, and possibly disease. Earlier research suggests that mortality of young between egg laying and one year of age exceeds 94% (Alford, 1980). Landers et al. (1980) estimates that with such high mortality rates, the average adult female tortoise has a successful clutch once every 9-10 years. Depredation of both eggs and hatchlings results in a extremely low reproductive rate which may be a limiting factor to the recovery of the species. Predation on both eggs and hatchlings has been documented in other studies (Butler and Sowell, 1996; Casey and Cude, 1978; Fitzpatrick and Woolfenden, 1978; Landers et al., 1980; Smith, 1995; Wilson, 1991) and predators of tortoise eggs and hatchlings include mammals, birds, reptiles, and insects.

Throughout the southeastern U.S., red imported fire ants, Solenopsis invicta, have established themselves as aggressive exotics. Originally introduced in Mobile, Alabama around 1930 (Vinson and Sorenson, 1986), *S. invicta* are dominant throughout Mississippi, having replaced many other Formicidae (Mount, 1981). The potential negative impact of S. invicta on native wildlife populations in the southeast is documented in Allen et al. (1994). Many species of terrestrial oviparous herpetofauna may be susceptible to fire ant impacts (Mount et al., 1981; Allen et al., 1996). Landers et al. (1980) observed that 10 gopher tortoise hatchlings in their reproductive study were killed by fire ants before emerging from the nest. In a study conducted by Smith (1995), 16 hatchlings from five different nests were destroyed by ants although the ant species responsible was not identified. Fire ant colonies can be found on burrow aprons throughout the range of the tortoise in Mississippi (Thomas Estes, pers. comm.). Jennings and Fritts (1983) found eight of 17 active burrows to contain fire ant colonies on the burrow apron (the authors do not mention whether these were native or non-native fire ants). During two years of life history and population structure research at Camp Shelby, Tuma (1996) recorded at least two tortoise hatchlings depredated by fire ants. Additionally, non-lethal exposure to fire ant venom may result in reduced weight gain and survivorship; as well as loss of digits and feet (Allen et al., 1996; Giuliano et al., 1996). In a laboratory setting approximating field conditions, Redbellied sliders (*Pseudemys nelsoni*) may experience greater than 70% mortality of hatching and pipping individuals when fire ants are present (Allen et al., unpub. manuscript). In addition, predation by *S. invicta* on adults of other species of turtles, (*Terrapene carolina triunguis*) has been documented (Montgomery, 1996).

Gopher tortoises may be vulnerable to fire ants at several life-history stages (Montgomery, 1996). Limited evidence indicates adults may be vulnerable. Pipping eggs are vulnerable to predation and newly hatched young may be stung which can lead to reduced survival by reducing weight gain and causing secondary infection through the necrotic action of the venom leading to death (Allen at al., 1996). Finally, small tortoises may also be vulnerable to both direct and indirect impacts. Because of the invertebrate fauna associated with gopher tortoise burrows, and a micro-climate attractive to fire ants, fire ants may forage heavily into burrows, increasing the possibility of contact. In addition to the potential impacts on gopher tortoises, the use of the burrow chamber by fire ants may have negative impacts on the fauna of the entire burrow system.

Methods

1) Study sites: 5 pairs, 20-40 hectares in size each, containing resident tortoise colonies. 5 sites will be used for controls for treatment with LOGIC®.Pairing of sites to reduce heterogeneity will be on the basis of gopher tortoise populations, *S. invicta* densities and overall habitat similarities.

2) *S. invicta* densities will be determined at each site by placing multi-species ant baits along two 200-meter transects (20/ transect) through each study site. Baits will be collected after one hour and the number of *S. invicta* recruiting to the bait will be quantified. While quantifying *S. invicta* levels, sampling to determine *S. invicta* use of

burrow systems and the impact of *S. invicta* on burrow commensals will be done using baits placed in burrows, D-vac suction apparatus, and light traps.

3) Adult female tortoises will be trapped annually within the study sites prior to the nesting season. They will be manually palpated to evaluate gravidity and standard measurements taken. Measurements include carapace length (CL), plastron length (PL), mass, anal notch (AN), anal width (AW), gular projection (GP), total thickness (TH), and maximum body width (BW).

4) Gopher tortoise nests will be located at each site. For each nest located, date of deposition (if known), incubation period and clutch size will be recorded. Number of eggs, depth from the soil surface to the uppermost egg, distance from the burrow entrance to the center of the nest, placement of eggs and approximate nest dimensions will be recorded.

5) Nests will be protected from all other predators with a wire mesh enclosure as described in Smith (1992) and checked daily to monitor disturbance. Unprotected nests will also be monitored for predator disturbance. Tracks and characteristics of burrow excavations will be used to identify the type of predator. Once the hatchlings emerge, straight-line carapace length (CL), plastron length (PL), and wet body mass of hatchlings will be recorded and AVM hatchling transmitters will be attached. The hatchlings will be tracked for the duration of the study or until mortality occurs.

6) The LOGIC® applications will occur in the spring and fall of 1998 and the spring of 1999. If ant densities are reduced significantly, the fall 1998 treatment may not be necessary. As stated above, only one member of each pair will be treated with the pesticide at a rate of 1.67 kilograms per hectare. This is the recommended application rate for broadcast treatment. The treatment will be conducted under the supervision of Homer Collins, entomologist with the USDA Plant Protection Station in Gulfport, MS. Broadcast application will be completed by either manual spreading or with the use of mechanized ground equipment. There will be no aerial application. The total are proposed for treatment of the 5 sites will not exceed 200 hectares.

Preliminary Results

Mound counts were performed on four unforested sites. There was no significant difference ($P>0.05$) between sites in the total number of ants or the total number of RIFA present before the LOGIC application, however, significant differences ($P<0.05$) were noted between sites after the application. Using a T-test, significant differences were observed in the both the % colony kill and the population indices between treated and untreated sites.

Ant bait transects were sampled at 10 sites immediately prior to treatment. A total of 400 baits were collected and no significant differences were observed in either the number of ants (P=.342), or the number of RIFA (P=.242) present between treated and untreated sites. After the treatment, significant differences were observed in the number of RIFA present between treated and untreated sites (P=.002), however, no significant difference (P=.082) was observed in the number of ants present.

The insignificant differences noted in the number of ants present between treated and untreated sites after treatment could be explained in a number of ways. In the treated sites, a number of species appeared to have increased their numbers after the treatment. A species that responded well to decreased *S. invicta* numbers was *Dorymyrmex bureni*. *D. bureni* numbers were significantly (P=.022) larger in treated areas than in untreated areas after treatment. While this may appear to reflect an increased population size, it may be a sampling artifact. When RIFA dominate a bait, *D. bureni* may not be represented on the bait while they may be present on the site. The reduction of RIFA densities may allow them better representation on the bait while not necessarily increasing their overall population size. Real population level changes will be easier to discern in the next two years of this study as a second treatment (Spring 1999) continues to reduce *S. invicta* numbers on the treated sites.

While no significant differences were noted in the total number of ant species present between sites either before or after the treatment, a negative correlation ($r=-0.463$, $df=39$, $P<0.01$) was observed between the number of ant species on site and the density of RIFA on site.

A total of 19 gopher tortoise nests was located in the 1997 field season. This represented a total of 51 intact eggs, which resulted in 7 hatchlings. Of these seven hatchlings, none are alive. They were all dead prior to the nesting season of 1998. The 1998 nesting season yielded a total of 26 nests, representing 99 intact eggs. Forty eight of these eggs hatched successfully and 21 hatchlings had transmitters attached. Of these 21 originally transmittered, only six remain alive to date.

Initial results seem to indicate increased survivorship at treated sites. While mortalities did occur at treated sites, none of these can be attributed to RIFA. In contrast, hatchlings on untreated sites were often found covered with fire ants. It is possible that these tortoises were killed by another predator, however, no visible damage to either the shell or the body parts was ever noted.

Cooperators/Acknowledgments
MS Army National Guard
The Nature Conservancy, MS Field Office
MS Department of Wildlife, Fisheries and Parks
MS Natural Heritage Program
Clemson University
USDA Forest Service
Eckerd College
USDA-ARS, CMAVE
USDA, Gulfport Plant Protection Station
Novartis Crop Protection

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SUMMARY

Experiments were conducted to estimate the flight capabilities of fire ant (*Solenopsis invicta* Buren) alates. These experiments were designed to (1) quantify energetic expenditure during fixed flight, (2) characterize metabolic substrate of male and female alates, (3) estimate flight speed of male and female alates, and (4) quantify wingbeat frequency and water loss during flight. Flying males (in closed-system respirometry) increased metabolic rate approximately 38.4-fold over resting rate. Females increased metabolic rate approximately 51-fold (closed-system respirometry) and 48-fold (flow-through respirometry) over resting rate (Table 1). Female alates had mean respiratory quotient (RQ) of 0.999, indicating carbohydrate flight fuel. Mean RQ of males was significantly lower (0.867). Female flight speed on a circular flight mill averaged approximately 0.7 m sec^{-1}, and increased with temperature (Fig. 1) but decreased with increasing body mass (Fig. 2). Male flight speed was 43% greater (approximately 1.0 m sec^{-1}) and increased linearly with temperature and increasing body mass. Female alates lost an average of 1.8 mg water h^{-1} during flight. A simple energetics model, combined with previous work on nutrient content of *S. invicta* and patterns of CO_2 release observed in this study (Fig. 3), indicate that flight capability of *S. invicta* alates is probably limited to <5 km in the absence of wind.

Text and figures submitted for publication in The Journal of Insect Physiology.

Table 1. Flight performance of male and female *S. invicta* during closed-system and open-system respirometry.

Sex	n	Temp. (°C) ($\bar{x} \pm$ SD)	Mass (g) ($\bar{x} \pm$ SD)	Flight time (min) ($\bar{x} \pm$ SD)	$\dot{V}_{O_2}$ (ml $g^{-1}h^{-1}$) ($\bar{x} \pm$ SD)	$\dot{V}_{CO_2}$ (ml $g^{-1}h^{-1}$) ($\bar{x} \pm$ SD)	RQ ($\bar{x} \pm$ SD)	Increase over resting $\dot{V}_{O_2}$
Male (closed system)	10	32.6 ± 0.6	0.0073 ± 0.0006	12.0 ± 6.6	47.6 ± 18.4	31.2 ± 12.8	0.867 ± 0.052*	~35.5X
Female (closed-system)	12	27.9 ± 0.7	0.0155 ± 0.0006	15.4 ± 13.2	19.8 ± 3.6	15.4 ± 3.1	0.999 ± 0.189	~47.5X
Female (open-system)	10	33.6 ± 1.0	0.0152 ± 0.0010	51.7 ± 19.9	33.8 ± 4.7[a]	29.3 ± 4.1	N/A	~48.0X

* RQs of male and female alates differ significantly (t-test, P=0.036).

[a] Estimated using $\dot{V}_{CO_2}$ in flight and RQ estimated in closed-system respirometry.

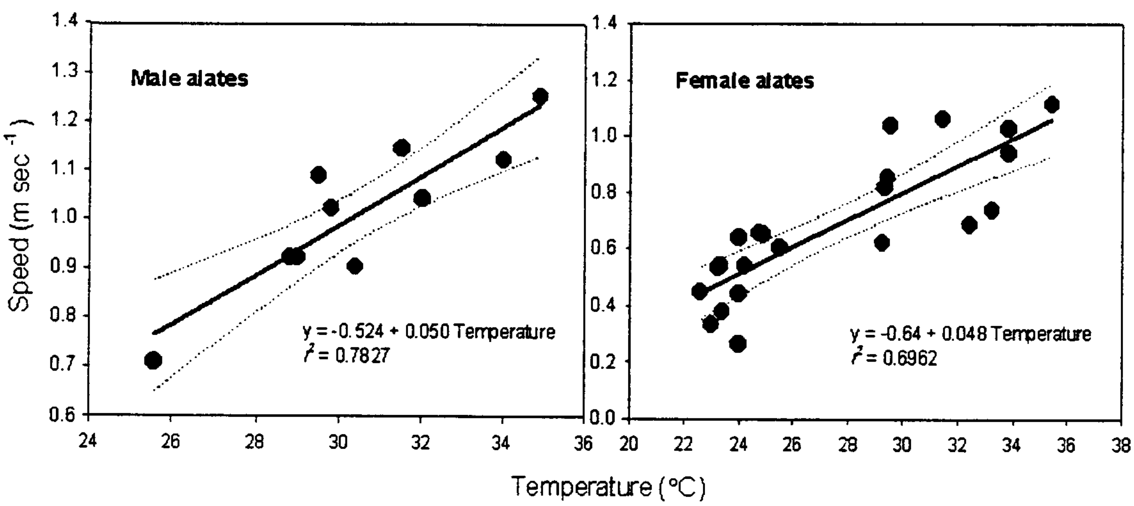

FIGURE 1. Relationship between temperature and flight speed in *S. invicta* alates. The dotted lines enclose the 95% confidence intervals for the regressions. Data have been adjusted for mean mass.

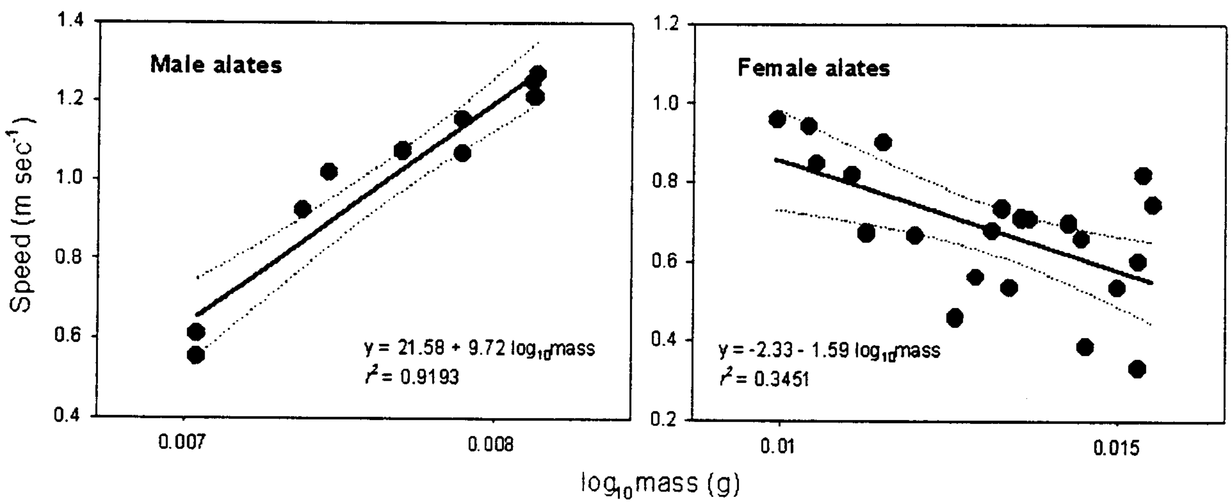

FIGURE 2. Relationship between $\log_{10}$-transformed mass and flight speed in *S. invicta* alates. The dotted lines enclose the 95% confidence intervals for the regressions. Data have been adjusted for mean temperature.

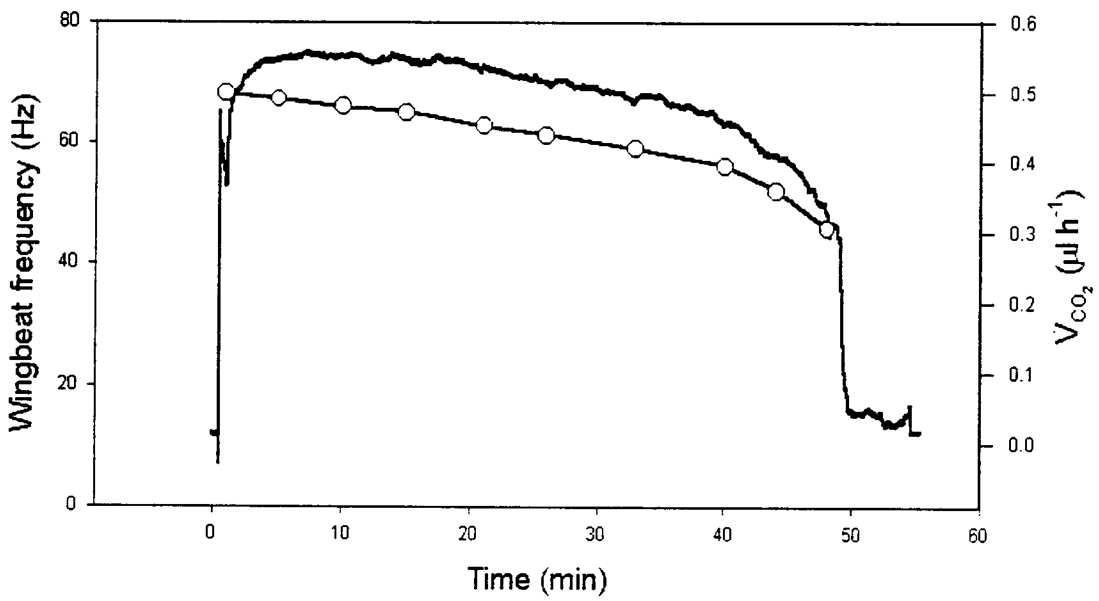

FIGURE 3. Real-time CO_2 emission and wingbeat frequency of an *S. invicta* female alate flying in a flow-through respirometer. The upper trace is $\dot{V}_{CO_2}$, the lower line and points are mean measurements of wingbeat frequency. Error bars are too small to project beyond the edges of the symbols. This pattern, including the rapid decline in $\dot{V}_{CO_2}$ at approximately 45 min., was repeated in females flying to exhaustion.

Hood, W.M. , P.M. Horton and J.W. McCreadie - EVALUATION OF THE IMPORTED FIRE ANT FOR CONTROL OF WAX MOTHS IN STORED COMB - The objective of this project was to assess the efficacy of the imported fire ant (IFA), *Solenopsis invicta*, in controlling wax moths. *Galleria* sp., in stored comb. Field studies were conducted rom 1995 to 1997 in 4 South Carolina counties that varied in IFA population density.

Supers of nine (dry) frames of undamaged drawn comb were stored by various arrangements on sites which ranged from 43 - 159 fire ant mounds per acre. All frames were placed in a freezer and held at 10°F (-12.2°C) for 12 hours to kill all life stages of wax moth prior to test. Each super was seeded with 3 wax moth larvae at field placement to ensure initial pest presence.

Tests plots were established each year during the first week in August with wax moth damage measurements made at 30-day intervals for 15-16 weeks. Wax moth damage was measured by placing a frame-size plexiglass grid (cm^2) over each side of a test frame and counting all squares that contained damage. The total amount of damage per super of nine frames was the test variable. IFA activity density (active ant mounds per acre) was recorded at the beginning of each test by multiplying the number of mounds within a 60 foot radius of a plot center by a factor of 4.3.

In 1996. wax moth damage was significantly greater ($P<.01$) in counties with lower IFA densities (Figure). In 1997 tests, significantly less ($P<.01$) wax moth damage occurred when five supers were stacked crisscrossed on a wooden pallet placed on the ground in areas containing 120 IFA mounds per acre. Comparisons were made with equipment stacked similarly with IFA excluded on the same site. IFA exclusion was made possible by stacking supers on a table that had legs sitting in no. 10 vegetable cans one-half filled with used motor oil. Other sites having less IFA density (43 and 86 mounds per acre) had greater ($P>.05$) wax moth damage.

The results of these tests indicate that beekeepers may use this method of biological control of wax moths only in areas having very high level IFA activity. The IFA did not damage the stored comb or wooden ware during these studies.

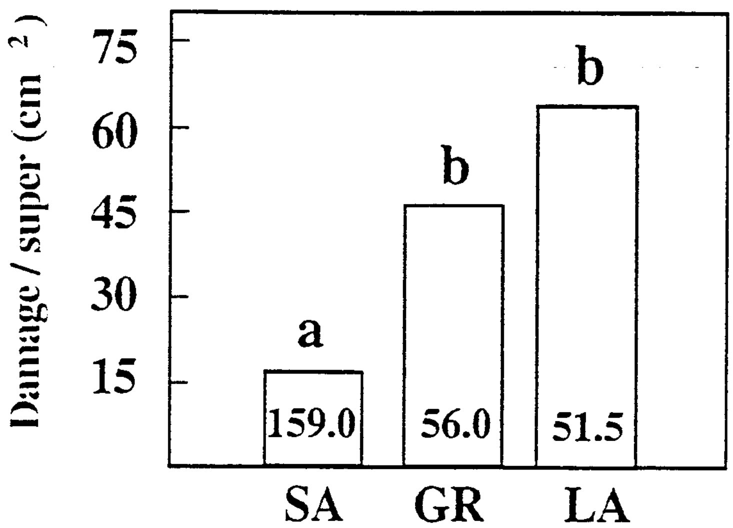

Figure — Comparison of wax moth damage (cm^2)/ super of nine frames. Numbers in bars represent the number of imported fire ant mounds per acre located on test sites in the 3 counties (Saluda. Greenville and Laurens).

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Effects of Ingesting Red Imported Fire Ants on Yellowfin Shiners

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The red imported fire ant Solenopsis invicta has become established throughout the southeastern United States since being introduced to this country in the mid 1930's. It is considered a nuisance and has been implicated in numerous fish kills. To determine if native fish feed on fire ants, and if consumption of fire ants has a negative impact on the fish, we conducted a number of experiments using yellowfin shiners Notropis lutipinnis. We established 22 replicate aquaria with 5 small fish (36 ± 5.9 mm; 0.4 ± 0.27 g; mean ± SD) and 22 replicate aquaria with 5 large fish (59 ± 7.5 mm; 1.7 ± 0.53 g). Two replicates of each size class served as controls. Each treatment group was fed fire ants ad libitum at 3-day intervals. Mean number (± SD) of fire ants eaten per replicate by small yellowfin shiners at first offering (6.1 st 3.02) was not significantly greater than the mean number eaten three days later (5.4 st 2.70). Mean number of fire ants eaten per replicate by large yellowfin shiners at first offering (16.6 ± 10.20) was significantly greater than the mean number eaten three days later (7.5 ± 3.52). We recorded one mortality after first feeding and three mortalities after second feeding of ants to small yellowfin shiners. We recorded three mortalities after first feeding and one mortality after second feeding of ants to large yellowfin shiners. Preliminary results suggests that large yellowfin shiners may learn to avoid ingesting fire ants after a single exposure, and ingested fire ants may be lethal to yellowfin shiners when consumed in even moderate number.

The Effect of Fire Ants on Soybean Germination and Growth

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The fire ant, Solenopsis invicta, significantly reduces soybean crop yields. This has been primarily attributed to fewer plants per row, because the ants attack the germinating seeds. Through a series of experiments we determined that the fire ants affects the soybean plant through all of its growth stages. During seedling development fire ant foraging activity shifted from the stedcotyledon to the roots, despite fresh weight increases for each region, and the fact that the stedcotyledon contained the majority of food reserves. Damage was visible, but only occurred prior to emergence and greening of the cotyledons. Fire ant association with seedlings germinated in soil resulted in reduced seedling vigor, as determined by a doubling of delayed emergent seedlings, a threefold increase in malformed seedlings, and visible damage to cotyledons. Seeds germinated and grown to mature plants in association with fire ants, allocated 43% more assimilate into pods, but produced 28% less root dry matter, and there was an 81% reduction of in root nodules compared to control plants. We propose that reduced root development and inhibition of nodule formation would be major yield limiting factors under the rigors of field conditions. The loss of dry matter may have been the result of fire ant feeding directly on the root system and the increase in pod production the result of redirection of carbon from the roots/nodules to developing pods. We have defined fire ant damage to soybeans and demonstrated that more research should be directed at the subterranean activities of the fire ant.

Bait Treatment of Fire Ants and Acceptance of Newly-Mated Queens: A Comparison of Hydramethylnon, Fenoxycarb, and Avermectin

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We previously demonstrated that in colonies where the queen is lost, the normally territorial workers become non-aggressive toward non-nestmate conspecific workers. Even more surprising was that these workers now readily adopted newly mated queens (NMQs). Hydramethylnon is known to often kill the queen but leave some workers unaffected. We demonstrated that field sites treated with hydramethylnon developed nucleus polygyne populations, probably through the adoption of multiple NMQs by queenless worker groups. In this study we compared under laboratory conditions the effect of hydramethylnon, that kills the queen with the effect of fenoxycarb and abamectin, both of which effectively sterilize the queen but do not kill her. Do workers that have non-functional queens adopt NMQs, as they would if their queen was dead or do they behave normally? Our results were unambiguous. In fenoxycarb treated colonies the colony queen's egg production decreased to only a few eggs per day, but she was still laying, and still releasing queen pheromones. Workers from these colonies executed all introduced newly mated queens. In avermectin treated colonies the queen's ovaries were destroyed and no egg production was observed. Under these conditions workers from these colonies still behaved as if they were queenright and executed all introduced NMQs. Only when the colony queen is actually killed, as in case of hydramethylnon treatment, do the workers adopt NMQs.

Semiochemicals Released by Electrically-Shocked Red Imported Fire Ants

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The red imported fire ant, Solenopsis invicta **Buren**, has evolved sophisticated chemical communication systems that regulate the activities of the colony. Among these are recruitment pheromones that effectively attract and stimulate workers to follow a trail to food or alternative nesting sites. Alarm pheromones alert, activate and attract workers to intruders or other disturbances. The attraction and accumulation of electrocuted fire ant workers in electrical equipment may be explained by their release of pheromones that draw additional worker ants into the electrical contacts. We investigated the semiochemicals released by electrically-shocked fire ants using an array of behavioral bioassays and gas chromatography. Workers from all size castes were subjected to a standard 120-Volt, alternating-current power source. In all cases shocked workers gaster flagged and curled their gaster in attempts to sting the wire. Other workers were quickly attracted to the wire, where they too were shocked. Gas chromatographic analysis showed that shocked workers released venom alkaloids, probably the result of the worker's attempts at stinging and gaster flagging. The shocked worker ants released bioassay detectable amounts of recruitment pheromones as measured in orientation and olfactometer bioassays. This suggests that fire ants respond to electric stimuli by releasing exocrine gland products, which include defensive and recruitment pheromones. Other semiochemicals are probably being released, but have not been detected via the bioassays available. Thus, the attraction of fire ants to electrical equipment can be explained by pheromone release upon being shocked, rather than an intrinsic attraction of the ants to electrical fields.

The Current Status of the Red Imported Fire Ant, *Solenopsis invicta,* in El Paso, Texas

by

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ABSTRACT

A survey was conducted during the months of May and June of 1998 in El Paso and western Texas, to determine the present distribution of *Solenopsis invicta* in this part of the state. A total of 408 random sites were sampled, 200 rural and 208 urban. *Solenopsis invicta* was found at three sites within El Paso. One of the sites was an arid environment, which is not a characteristic habitat for *S. invicta*. The presence of *S. invicta* at this arid site urges further investigation.

INTRODUCTION

The red imported fire ant, *Solenopsis invicta* Buren, was originally found in temperate habitats in South America (northern Argentina, Paraguay, and southern Brazil). *Solenopsis invicta* apparently arrived in the United States through Mobil, Alabama between the 1930's and the early 1940's on South American ships transporting agricultural goods or soil ballast. During the 1940's and 1950's, *S. invicta* began an extensive and rapid spread from Mobil, Alabama, throughout the southeastern states of the United States (Klein, et al., 1997). By 1985, *S. invicta* had invaded 11 states from Florida to Texas (Vinson and Sorensen, 1986), and was expected to move into irrigated areas and along permanent lakes and rivers of West Texas, New Mexico, and Arizona (Vinson and Sorensen, 1986). At the present time, S. *invicta* has spread throughout much of Texas, Southern New Mexico, and has entered California. It has recently been reported in El Paso, Texas, the westernmost part of Texas (Mackay and Fagerlund, 1997).

A survey was conducted in the western part of Texas during the months of May and June of 1998 to determine the distribution of *S. invicta* in the area. The objective of this report is to summarize the results of our survey.

METHODS AND MATERIALS

This survey was conducted in El Paso, Texas located in the northern Chihuahuan Desert. The climate of northern Chihuahuan Desert is arid to semi-arid, with an average of 230 mm of annual precipitation. This region is characterized by three seasons. A hot-dry windy spring season occurs during the months of April through June, with daily temperatures ranging from 20°C to 35°C, with 12% of the mean annual precipitation. **A** hot-summer season during the months of July through October has daily temperature extremes over 40°C, accompanied by 64% of the mean annual precipitation. A cold-dry winter season occurs during the months of

November through March with normal daily minimum temperatures of 0°C. It is not uncommon for the temperature in El Paso to drop to –5 °C during the winter months.

El Paso is an urbanized area with an abundance of well-watered grassy areas, a habitat that appears to be favorable for *S. invicta.*

Procedure – Imported Fire Ant Survey

The survey was conducted from May 15 through the end of June of 1998. A total of 400 plus sites were sampled, 208 urban and 200 rural. The 208 urban sites were selected by randomly generating 220 sets of coordinates and locating sites on a gridded map. Some of the coordinates were not usable because they were located in parking lots and highways. The 200 rural locations were randomly selected, based on the accessibility and availability of desert sites surrounding the urban sector on the west, east, northeast and south parts of the city. At each sampling site the following information wàs recorded: GPS locations, vegetation description, and answers to questions on the survey form (Appendix 1), which were obtained from the residents contacted at the time of the survey.

A total of 20 baits were placed at each urban sampling site, 10 surface baits and 10 subterranean baits. One ounce condiment "Dixie®" cup and lid, containing one piece of tuna flavored Tender Vittle® cat food was used as surface bait. The piece of cat food was sprayed with water to increase the moisture content. The subterranean baits consisted of a meal worm placed in a Corning ® # 25702, 2 ml cryogenic vial approximately 1 cm diameter and 4 cm long with ten 2.4 mm drilled holes. Nine of the holes entered the tube and the tenth hole at the bottom of the vial was used to attach a string for retrieval. The vials were buried approximately 5 cm intọ the ground. The cups and subterranean baits were labeled B1-B5 (placed in the back yard of the sampling site) and F1–F5 (placed in the front yard of the sampling site) (see Appendix 1). The surface baits were retrieved after 30 minutes, the subterranean baits after 24 hours. Reclosable plastic bags were used to store and transport capped surface baits to and from the sampling sites. The surface baits were stored in ice coolers while the samples were being collected, and were placed in the freezer at -26°C to kill the ants in the cups. The subterranean baits were pulled up and inspected at the site for the presence or absence of ants. If ants were detected, the cryogenic vial was placed inside a prelabeled scintillation vial with 70% ethanol.

The procedure for sampling at the rural sites was the same as the one for sampling at the urban sites, except that the labels for the cups changed to L1–L5 (left side of the road) and R1–R5 (right side of the road).

Additional Sampling in Areas with *Solenopsis invicta*

The same procedure was used for sampling 53 sites at the UTEP campus and 53 sites at Chamizal National Memorial areas where *S. invicta* was found. At Chamizal National Memorial, areas such as the visitors' center, the parking lots, and paved roads were excluded when the sites were randomly generated. In areas labeled as public liability zones (the bowl area of the outdoor stage and the area surrounding the visitors center), a meter by meter search was conducted to locate and treat *S. invicta* mounds. The public liability zones were approximately 3.5 hectares in size. AMDRO, Logic, Extinguish, and combinations of AMDRO/Logic and AMDRO/Extinguish were applied according to manufacturer's guidelines. The combination treatments were half of the prescribed amounts of each insecticide. Treatments were placed in two 45 ml centrifuge tubes. The centrifuge tubes had ten 2.4 mm holes drilled in the top of the tube so that the ants could access the insecticides. The centrifuge tubes were buried 30 cm deep at the base of the mounds. This was done to provide some protection to native ants while providing access for *S. invicta*. We checked for mound movement and activity for the next six weeks after treatment.

Solenopsis invicta was detected at a residence on Sunset Drive in west El Paso. The surrounding area was extensively sampled to determine the extent of the infestation. Sampling was conducted using seven transects, each with five or six cups, depending on the size of the yard. The transects were placed ten meters apart and the cups were placed every 5 meters. This modification of the sampling protocol was done to determine how widespread the red imported fire ant was at this site. The rest of the procedures for sampling this area were the same as the methods used in the original survey.

Samples of mounds were collected along other areas of Sunset Drive, Olmos Street, and Couer 'dAlene Circle using scintillation vials. When mounds were located at a residence, several ants were collected in the vials by imbedding the vial in the mound. The vials were capped and the ants were preserved in 70% ethanol. Approximately 2-4 vials of ants were collected at each site.

RESULTS

We found *S. invicta* in 3 areas in the El Paso region: University of Texas at El Paso (UTEP), Chamizal National Memorial, and Sunset Drive and surrounding areas (Map 1). They were not found in the surrounding desert. A total of twenty-five species of ants were identified from the 584 urban and natural ecosystem sites that were sampled (Table 1).

University of Texas at El Paso

Solenopsis invicta was identified at one of the 53 sites that were sampled on the campus: the front and back of the library building. This area is a mesic habitat, which includes shade trees, ornamental evergreen shrubs, lawn, and a variety of ornamental annuals.

Chamizal National Memorial

Solenopsis invicta was identified in the bowl area of the outdoor stage in Chamizal National Memorial. *Solenopsis invicta* was confirmed at 36 of the 53 sampling sites. *Solenopsis invicta* was also found throughout the 22.45 hectares memorial, but not in adjacent areas. A total of 113 mounds were identified as *S. invicta* in the bowl area alone. Shade trees, evergreen shrubs, and a variety of grasses characterize the habitat where the nests are located.

Sunset Drive and Surrounding Areas

Solenopsis invicta was found at the study site and was determined to occupy an area within 13 hectares around the original site on Sunset Drive. These sampling sites include mesic and xeric landscapes and are located near the Rio Grande/Rio Bravo River.

Other Ants

Other species of ants found in this study may affect *S. invicta* either as predators on founding queens, or as competitors. *Solenopsis xyloni* and *Forelius pruinosus* were identified in association with *S. invicta* at the three sites (Table 1). Overall in the urban survey *S. xyloni* and *F. pruinosus* were the predominate species, however, *S. invicta* was the dominant species when the three species occurred together (Tables 2-4).

Table 1: Species of ants collected in El Paso, Texas and surrounding areas.

Subfamily	Genera	Species
Dolichoderinae	*Dorymyrmex*	*bicolor*
		insanus
		new species
	Forelius	*maccooki*
		pruinosus
Formicinae	*Formica*	*perpilosa*
	Myrmecocystus	*mimicus*
	Paratrechina	*terricola*
		vividula
Myrmicinae	*Aphaenogaster*	*cockerelli*
	Monomorium	*minimum*
	Pheidole	*crassicornis*
		dentata
		hyatti
		spp.
	Pogonomyrmex	*californicus*
		maricopa
		rugosus
	Solenopsis	*amblychila*
		aurea
		invicta
		krockowi
		xyloni
		new species
	Trachymyrmex	*smithi*

Other species of ants were also identified at the University of Texas at El Paso study site, but *S. invicta* was the dominant species (Table 2).

Table 2: Species of ants found around the library at the University of Texas at El Paso. Percent is based on total numbers of foragers captured.

Species	Percent
Solenopsis invicta	50.0
Solenopsis krockowi	21.4
Solenopsis xyloni	7.14
Forelius pruinosus	21.4

A total of 15 species of ants were identified at the Chamizal National Memorial. *Solenopsis invicta* and *S. xyloni* were identified as codominant species (Table 3).

Table 3: Species of ants at the Chamizal National Memorial.

Species	Percent
Dorymyrmex insanus	0.3
Forelius maccooki	0.7
Forelius pruinosus	6.4
Formica perpilosa	1.5
Myrmecocystus mimicus	0.3
Pheidole crassicornis	0.7
Pheidole dentata	7.4
Pheidole hyatti	1.2
Pheidole spp.	1.2
Pogonomyrmex californicus	0.3
Pogonomyrmex maricopa	1.0
Pogonomyrmex rugosus	0.3
Solenopsis invicta	30.0
Solenopsis krockowi	17.0
Solenopsis xyloni	30.0

Three species of ants were identified at the Sunset Drive study site, of which *S. invicta* is the dominant ant species (Table 4).

Table 4: Species of ants at the Sunset Drive and surrounding areas.

Species	Percent
Forelius pruinosus	33.3
Solenopsis invicta	55.5
Solenopsis xyloni	11.1

DISCUSSION

Solenopsis invicta disperses using several methods, including mating flights, dispersal through infested agricultural goods, and by floating on the surface of water. Dispersal through agricultural goods is the most important mode of infestation. It is not known how the red imported fire ant was introduced to the UTEP campus, but it is suspected to have been imported by infested plants. Dispersal of *S. invicta* occurs when infested agricultural items such as soil, sod, and trees are shipped from one state to another (Lofgren, et al., 1975). It is suspected that Chamizal received a shipment of trees from San Antonio, Texas (a quarantined county) in the mid 1980's. The trees were transported in a closed trailer.

The colonization of *S. invicta* depends on abiotic factors such as weather, rainfall, and soil properties. The optimum temperature range for *S. invicta* is between 22°C and 30°C (71°F and 86° F) (Lofgren, et al., 1975). Soil moisture is essential for mound building, therefore, an average of 25 cm (10 inches) or more rainfall a year is thought to be required for their survival.

Solenopsis invicta was not expected to disperse to the southwest due to the xeric environmental conditions of the desert, but it has been shown to colonize urban habitats in outer areas. The successful colonization of *S. invicta* was presumed to depend on a mesic habitat (Moody, et al., 1981), which appears to be the case in the arid southwest.

Our results show that nests of the red imported fire ant were mostly confined to landscaped areas. There are a number of reasons that may explain why the ants have not spread into other areas at the UTEP campus. The first reason could be that UTEP campus maintenance does insecticidal treatments, including treating of ant mounds. A second reason is that the campus is highly subdivided by buildings, sidewalks, streets, and rock walls. This could prevent newly mated queens from dispersing. A third reason *S. invicta* has not spread to other areas on campus could be because it just arrived on campus.

The Chamizal National Memorial meets the optimum abiotic conditions for the successful colonization and dispersal of *S. invicta.* The memorial is watered very frequently (over 90 cm/year) keeping the ground moist (not flooded). The lush vegetation includes a variety of grasses, shade trees, and evergreen bushes. Humans undoubtedly play an important role in the success of *S. invicta.* Visitors litter the grounds with picnic materials, providing the ants with sources of food. Another important factor which possibly enhances the dispersal of the ants at the memorial is the lack of subdivisions of the lawn. Consequently, the memorial has become infested with the red imported fire ant.

The spread of the red imported fire ant on Sunset Drive and surrounding areas cannot be easily explained, since this is predominantly an arid environment. The area includes rock landscape, a variety of cacti, and other desert vegetation. The presence of *S. invicta* at this arid site needs further investigation, since this habitat does not meet the basic abiotic conditions which were considered essential for the successful nesting, reproduction, and colonization of the ants. *Solenopsis invicta* may have become adapted to the arid conditions of the southwest. We find no morphological evidence of *S. invicta* and *S. xyloni* producing a hybrid. Further studies must be conducted in the southwest to assess the potential of *S. invicta* to successfully colonize this part of the country.

ACKNOWLEDGEMENTS

We thank Jeremy Cook, Arlene Perez, Sandra Poole, Erick Orsorio, Mike Gaglio, Mario Chavez, and Veronica Trevizo of the University of Texas at El Paso Fire Ant Laboratory for their assistance in the field, and Claudia Valenzuela for help with the logistics. Special thanks are given to the Administration of Chamizal National Memorial, specifically Cordell J. Roy Superintendent, Jerome T. Flood Chief Park Ranger, and Jesus Bravo Pest Controller for the opportunity to conduct field studies. Assistance from the University of Texas at El Paso was provided by Tony Sullivan, Jose Granillo, Raed Aldouri, and the technical staff of the Geology Department to conduct field studies on campus and mapping assistance. We thank Mario Saavedra Chief Inspector Pesticide/Regulatory of the Texas Department of Agriculture for regulatory advice. Our research was supported by the Texas Imported Fire Ant Research and Management Plan.

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APPENDIX 1

UNIVERSITY OF TEXAS AT EL PASO
FIRE ANT SURVEY OF EL PASO

Collection No.: ______________________________

Name: ______________________________

Address: ______________________________

Phone Number ____________ Date: ________ Time: ________

Permission to enter yard, if not home: ______________________________

Latitude: _____° _____’ _____” Longitude: _____° _____’ _____”

See Back?

Front Yard

Plant Community Type: ______________________________ ☐

Water Schedule: ______________________________ ☐

Insecticide Schedule: ______________________________ ☐

Soil Type: ______________________________ ☐

Ant Impact: ______________________________ ☐

Opinion on Ants: ______________________________ ☐

Back Yard

Plant Community Type: ______________________________ ☐

Water Schedule: ______________________________ ☐

Insecticide Schedule: ______________________________ ☐

Soil Type: ______________________________ ☐

Pets (Species, number?): ______________________________ ☐

Fire Ants Present? ______________________________ ☐

PICK UP SUBTERRAEAN TRAPS ON: ______________________________

	F3		**F1**		**F7**	**F9**	
Front Yard		**F5**		House		**F10**	**Back Yard**
	F4		**F2**		**F6**	**F8**	

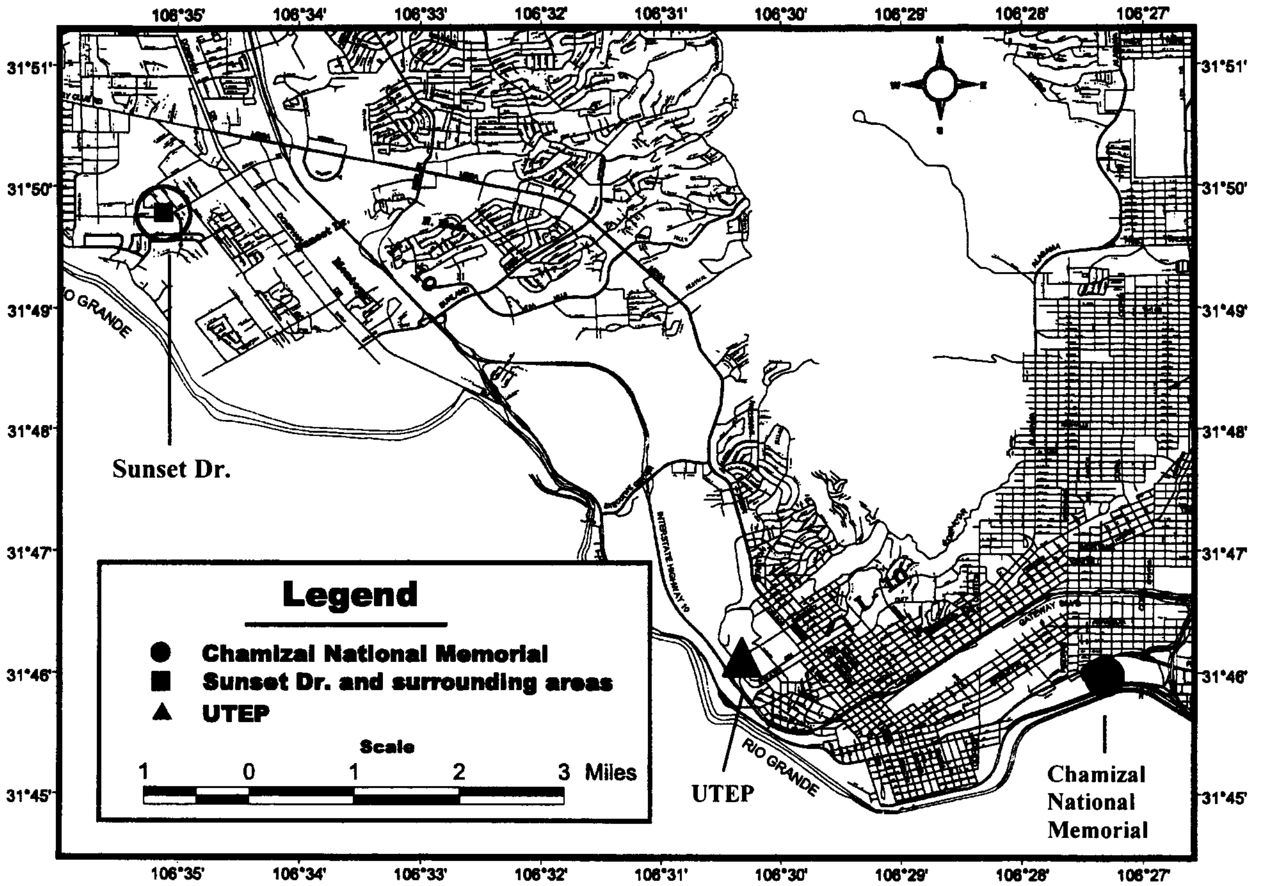
List of Species:

#	**Surface**	**Subterranean**
F1		
F2		
F3		
F4		
F5		
B6		
B7		
B8		
B9		
B10		

SEE BACK FOR NOTES ON:

Figure 1: Fire ant survey form.

Distribution of Fire Ants in El Paso



Map 1: Distribution of *Solenopsis invicta* in El Paso, Texas.

Field Releases of the Decapitating Fly, *Pseudacteon tricuspis*

Sanford D. Porter, USDA-ARS, CMAVE; Luiz Alexandre Nogueira de S‡, Embraba Meio Ambiente, Jaguariuna, SP, Brazil; Kathy Flanders, Auburn University, Auburn, AL; Lynne Thompson, University of Arkansas at Monticello, AR

Phorid flies in the genus *Pseudacteon* are a promising group for biological control of fire ants. Maggots of these miniature flies develop in the heads of fire ant workers, decapitating their host upon pupation. Fire ant workers are keenly aware of the presence of phorid flies. The presence of a single fly usually stops or greatly inhibits the foraging efforts of hundreds of workers in only a minute or two.

The overall impact of these flies on fire ant populations is still unknown; however, it is clearly sufficient to have caused the evolution of a number of phorid-specific defense behaviors. These behaviors could only have evolved if *Pseudacteon* flies had population-level impacts on the survival of fire ant colonies or the production of sexuals.

Our rearing techniques have gradually improved over the past year. Our laboratory is currently producing 800-1800 *P. tricuspis* flieslday and 100-300 *P. curvatus* flieslday. We are cooperating with the ARS laboratory in Starkville, MS to develop ways of further automating the process and improving production efficiency. We are particularly positive about our abilities to rear *P. cuwatus*. Once we are able to get this species out of quarantine, we should be able to rear twice as many flies as *P. tricuspis* with half the effort. Having a steady supply of flies has been the key to our current success in releasing *P. tricuspis.*

Permits to release *P. tricuspis* were granted to our lab in 1997. Three releases were conducted in the summer and fall of 1997. Flies have been recovered from one of these sites every month since October 1997, a period of more than 18 months. During this period the flies survived two winters, a flood, and a severe summer drought. Fly populations at this release site still appear to be increasing as evidenced by the numbers of flies observed and the percent of mounds attacked during these observations. These densities are already comparable to those found in South America. It will be very interesting to see if populations continue to grow in the coming year. The growth and persistence of flies at this site is very important because it proves that *P. tricuspis* can establish self-sustaining and apparently permanent populations on the red imported fire ant in the United States.

During the late summer and fall of 1998, flies were released at six additional sites in Florida (3), Alabama (1), Arkansas (1) and Oklahoma (1). Field-reared flies have been consistently recovered from all three of the Florida sites for the last 5-7 months. Field-reared flies were also recovered from the Arkansas site for two weeks before cold weather set in. Because of the onset of winter, we do not expect to recover flies from the remaining sites until spring 1999. We are currently monitoring fire ant populations at the release sites and paired control sites. We will begin assessing the impacts of phorid flies on fire ant populations in the next year or two after the fly populations have a chance to build up. We will also monitor rates of fly dispersal from the release sites. This information will allow us to determine the value of these flies as fire ant biocontrol agents and how many release sites we will need in each state to achieve maximum benefits in a predetermined amount of time.

Successful releases of these flies and other natural enemies will not eradicate imported fire ants, but they could help tilt the ecological balance in favor of our native ants. If this happens, fire ant populations in the United States could be reduced to levels similar to those in South America.

1998 UGA Field Evaluations

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[2]Extension Entomologist, Athens, GA

INTRODUCTION--The evaluation of new materials and methods for the control of red imported fire ants continues to serve as the cornerstone of research within the University of Georgia's fire ant project. From fall 1997 through fall 1998, 10 field evaluations were .conducted with labeled and unlabeled products from 6 companies. Included in these trials were **3** new baits, several new formulations of granular products, and 5 combinations of existing products. The trials included broadcast treatments, individual mound treatments, and combination treatments.

MATERIALS AND METHODS--All of the trials were conducted using a completely randomized design. Baits were broadcast using a Herd GT77 spreader mounted on a Honda ATV. Granular products were applied using a push-type broadcast spreader. Individual mound treatments were measured and applied with the use of standard measuring cups. Plots ranged in size from 0.5 to 1.0 acre with the pre and posttreatment counts being made in circular plots within the treated areas. Circular plots ranged in size from 0.25 to 0.5 acre. All granular treatments were followed with at least 0.1" water. All bait treatments were made under the most appropriate weather conditions. Ratings ranged from slightly disturbing mounds to digging mounds for population index rating. Data were analyzed with analysis of variance (ANOVA) and, where significant (p=0.05), means were separated with LSD (using PROC GLM of SAS).

RESULTS AND DISCUSSION--Several products (Amdro, Spectracide granules, Talstar, V71639, and fipronil) provided excellent control in some of the trials. However, very few 'new' products outperformed the standards used in each of the trials. Talstar outperformed the numbered compounds in one FMC trial (Fig. 4) and did as well as the numbered compounds in the second trial (Fig. 5). The broadcast application of Amdro did as well statistically as the Amdro broadcast followed by an individual mound treatment (Fig. 1). None of the products in the first Clorox trial were statistically better than the untreated control (Fig. 2). In the second Clorox trial, Spectracide granules were superior to the other treatments for the first month of the trial (Fig. 3). The Valent V-71639 products outperformed Logic throughout the trial and were statistically better than the UTC (Fig. 6). DE-105 afforded moderate control in one broadcast trial (Fig 7), good control at the higher rate in the second broadcast trial (Fig. 8), and moderate control in the individual mound treatment trial (Fig. 9). All of the fipronil products provided excellent control for 1 year (Fig. 10).

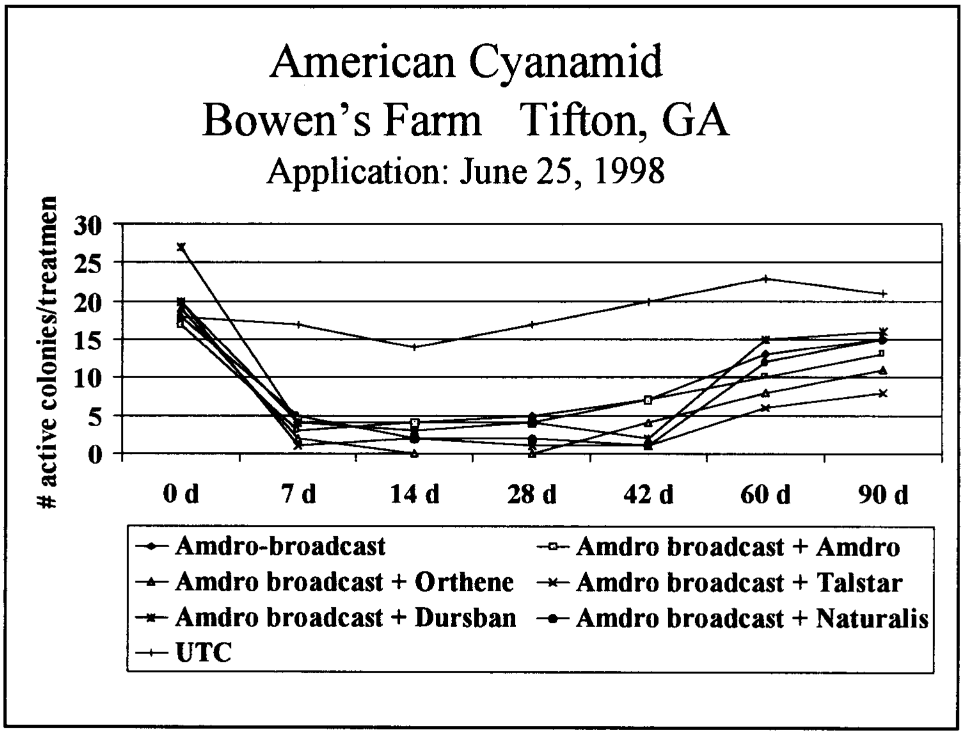

Fig. 1 Comparision of Amdro broadcast vs. Amdro broadcast followed by individual mound treatments applied at labeled rates. Treatments were replicated 4 times and results showed Amdro broadcast performed as well or better than Amdro broadcast followed by an individual mound treatment.

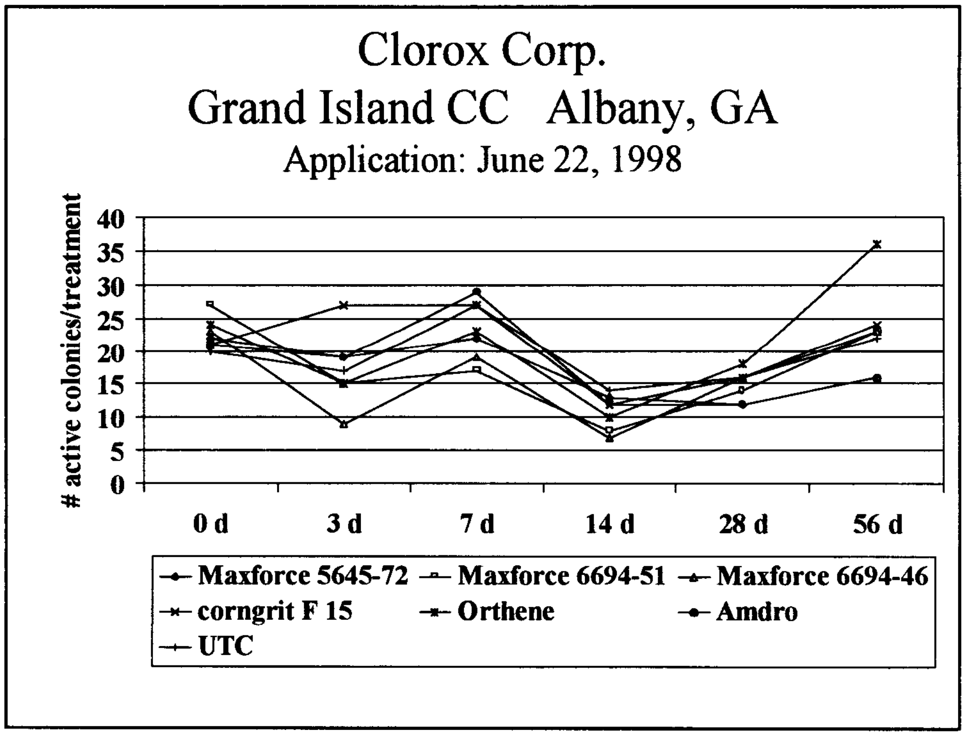

Fig. 2 Efficacy of various fipronil treatments as they compare to a competitive landscape. Treatments were replicated four times and the results showed no statistically significant differences in any of the treatments, including the control.

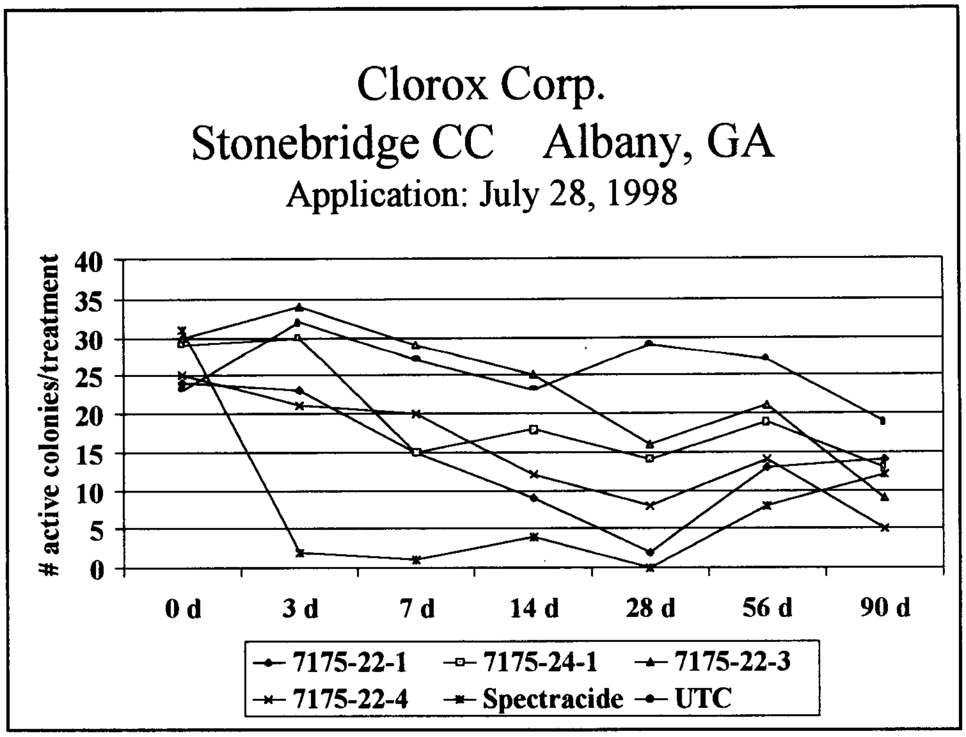

Fig. 3 Evaluation of various fipronil treatments and Spectracide granules. The treatments were replicated four times. Results showed excellent control from the Spectracide granules.

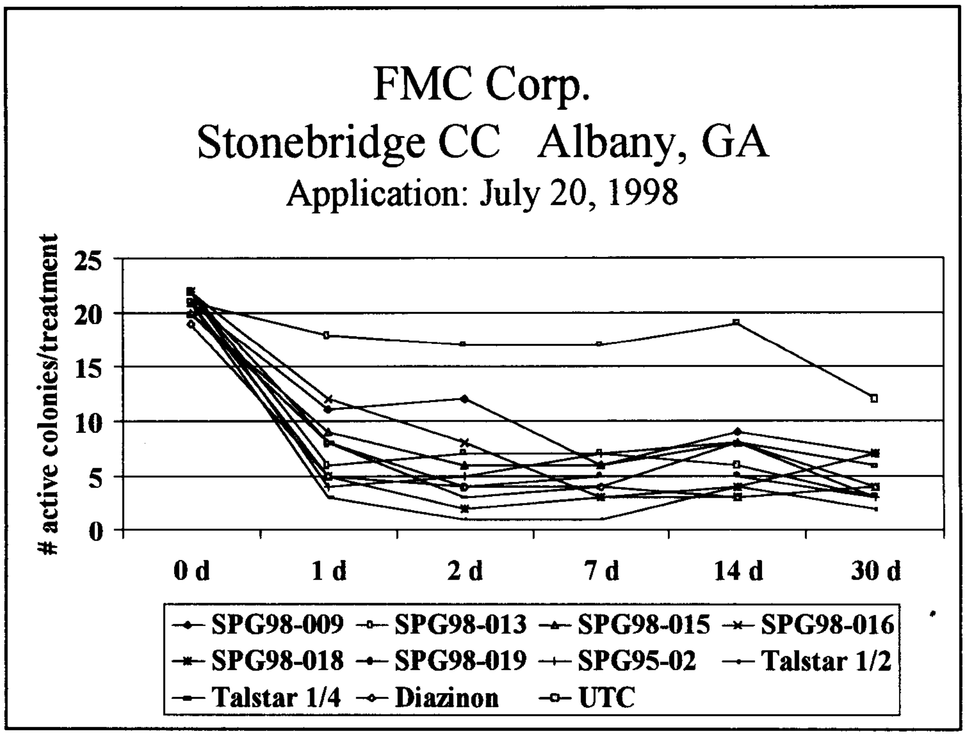

Fig. 4 Efficacy of bifenthrin mound treatments towards imported fire ants. Treatments were replicated four times and the results showed statistically significant differences in all of the treatments compared to the control at 2 and 7 days posttreatment.

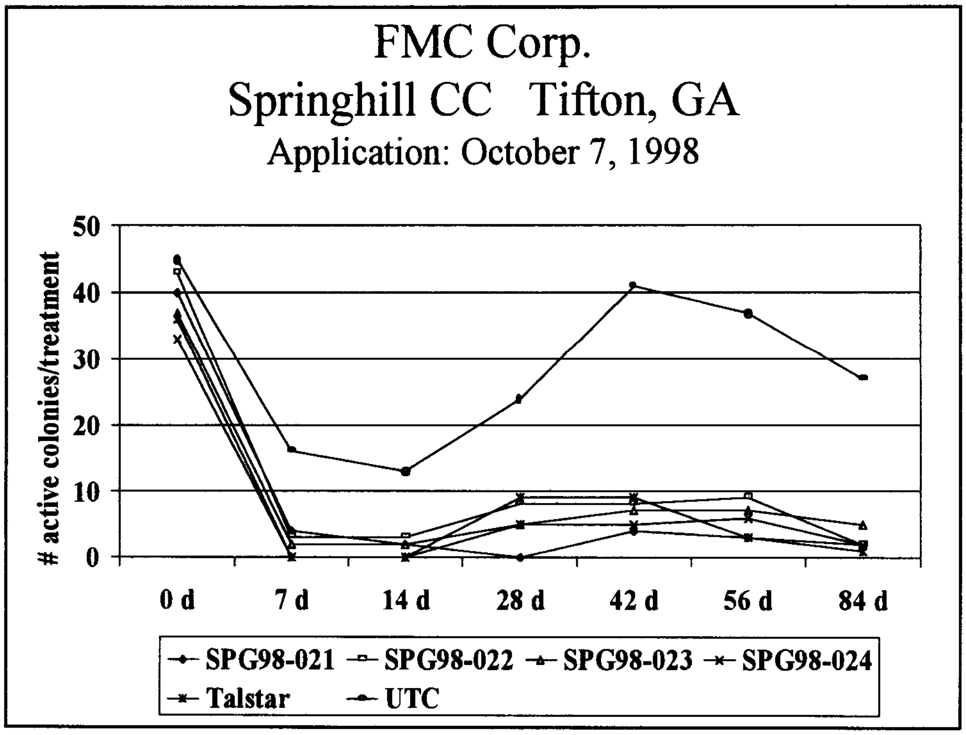

Fig. 5 Efficacy of bifenthrin granular mound treatments towards imported fire ants. Treatments were replicated four times and the results showed statistically significant differences in all of the treatments compared to the control from 7 days through 84 days posttreatment.

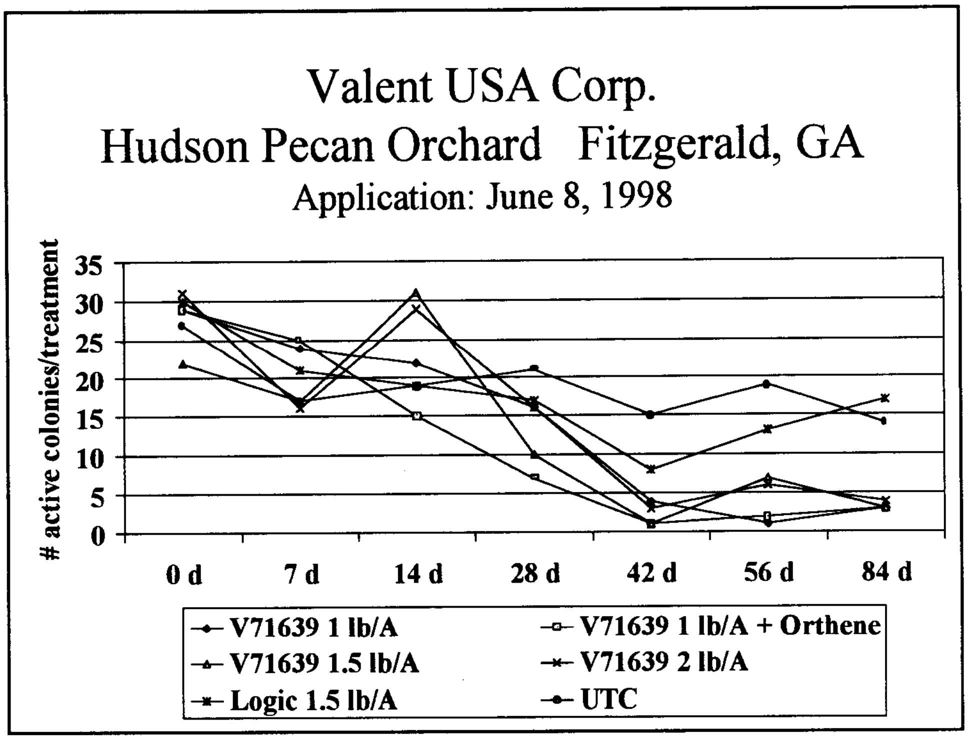

Fig. 6 Evaluation of different application rates of V71639 bait when broadcast for the control of imported fire ants. Treatments were replicated four times and the results showed statistically significant differences in the 2 higher rates as compared to Logic and the control.

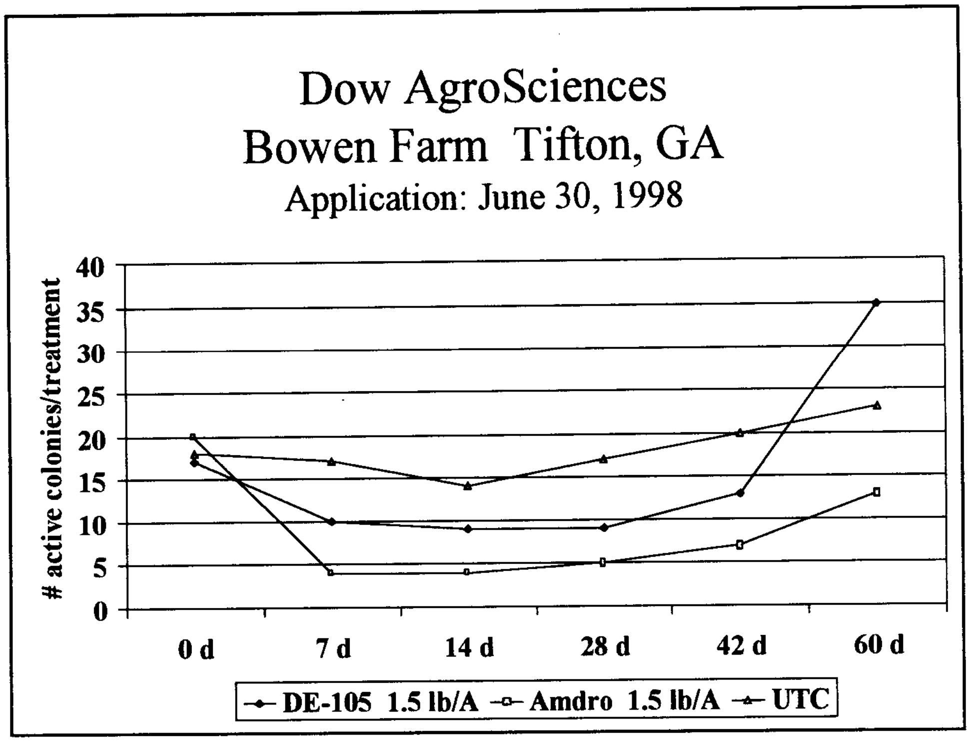

Fig. 7 Evaluation of Spinosad DE-105 bait when broadcast for the control of imported fire ants. Treatments were replicated four times. Numerically better control was observed by both treatments through the first 42 days compared to the control.

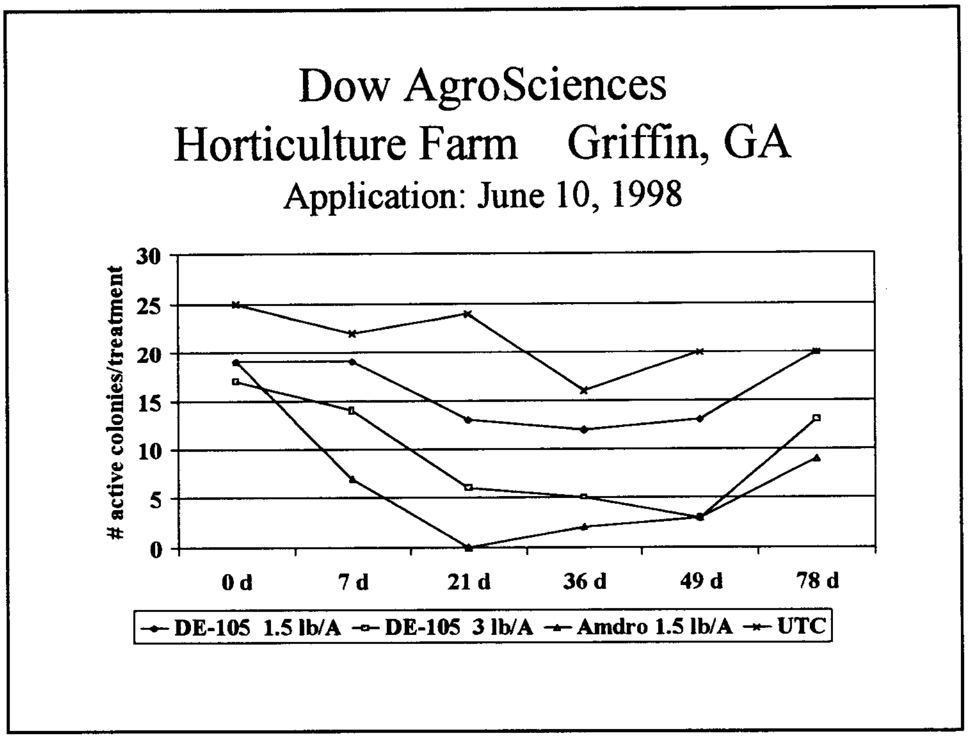

Fig. 8 Evaluation of Spinosad DE-105 bait when broadcast for the control of imported fire ants. Treatments were replicated four times. The higher rate of DE-105 provided control similar to Amdro.

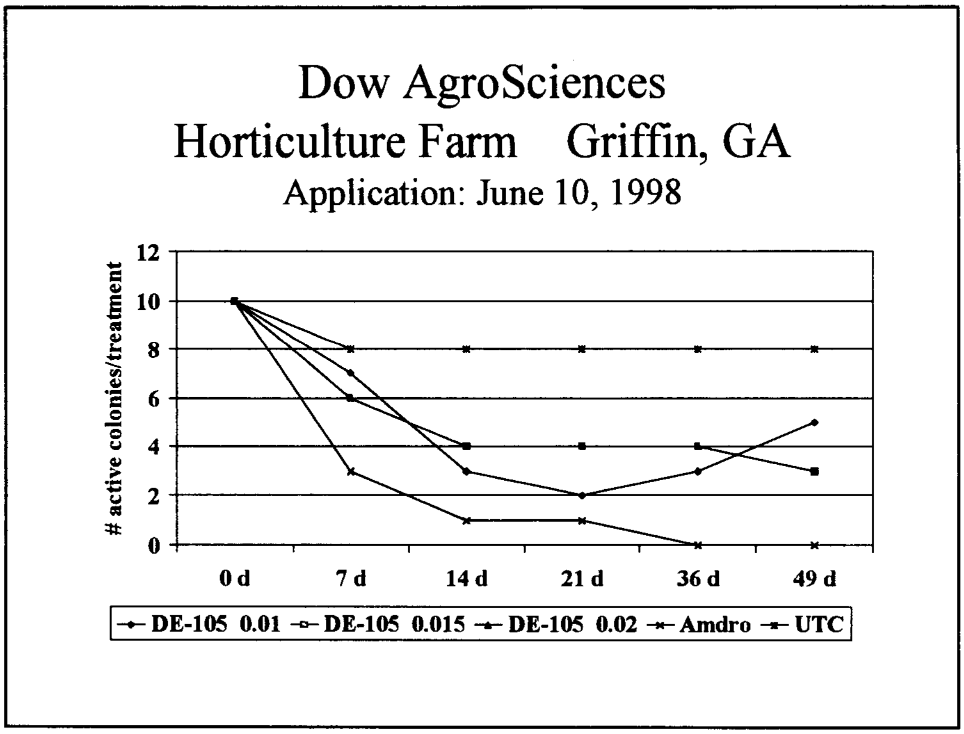

Fig. 9 Evaluation of Spinosad DE-105 bait when used as an individual mound treatment for the control of imported fire ants. Treatments were replicated four times. The three DE-105 treatments provided some control; however,efficacy was not as good as that provided by the standard.

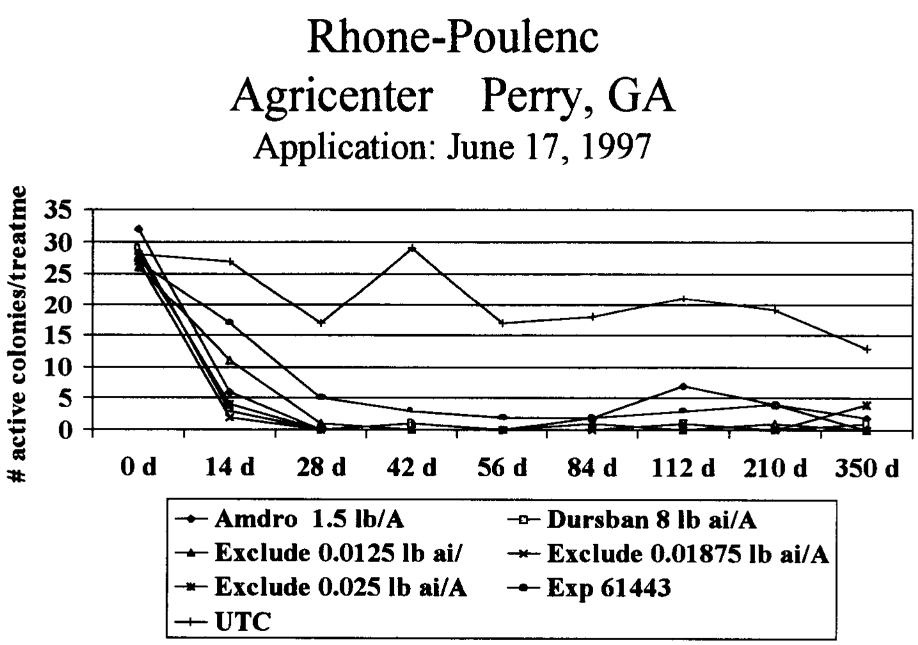

Fig. 10 Evaluation of fipronyl bait and granules when broadcast for the control of imported fire ants. Treatments were replicated four times. All of the treatments provided excellent control for 1 year.

BEHAVIORAL MODIFICATIONS OF FIRE ANT, *SOLENOPSIS INVICTA* INDUCED *BY* THE VENOM OF *MONOMORIUM MINIMUM.*

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ABSTRACT

Interference competition and aggressive behavior have been known to play important roles in the organization of ant colonies. Our earlier studies on the behavioral response of founding ***Solenopsis invicta*** colonies to ***Monomorium minimum*** incursion has given us an insight into the aggressive behavior of these two species. When the frequency of certain behaviors exhibited during confrontation by both species were plotted, one of the behaviors, gasterflagging (raising the abdomen and spraying venom) was observed to be the predominant offensive and defensive behavior used by both ***S. invicta*** and ***M. minimum.*** Thus, in this study our goal was to observe the detailed behavior of S. ***invicta*** when exposed to the venom of ***M. minimum.***

Further, the persistence of this venom on various substrates and their impact on foraging behavior of ***S. invicta*** are examined. The results showed that when a crude extract of the ***M. minimum*** was applied on a glass surface, ***S. invicta*** avoided walking on that surface or covered the surface with debris. The extract activity was observed to be persistent for three days, and a glass surface seems to hold the extract better than filter paper or polyethylene.

Bottlenecks, Introgression, and Male Fertility Across the Range of the Red Imported Fire Ant

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ABSTRACT

The range of the Red Imported Fire Ant examined in this study includes the Gulf States and the Eastern Seaboard to North Carolina. The Red Imported **Fireant** has spread quickly and has continued to expand its range through natural dispersal and movement of infested articles since it's introduction. In this study, we attempt to determine the genetic relatedness of populations across the range of the red imported **fireant** using transects and microsatellite analysis. The populations were analyzed using known microsatellite markers (Lu, 1998). Polymorphism of microsatellite loci are detected by polymerase chain reaction (PCR) amplification using primers based on the unique flanking sequences. Allele frequency gradients were observed with two of three primer sets and heterozygosity was observed with one primer set. In addition, the male fertility study leads to the belief that diploid production occurs during the overwintering months. The trends that have been observed to date are based upon partial collection from the predetermined transect sites.

Coexistence of Native Ants And the Imported Fire Ant. Study of An East Texas Meadow

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INTRODUCTION

Native ants are important in the maintenance of natural ecosystems and also provide control of invertebrate pests in agricultural and urban ecosystems. Exotic pest ants such as the imported fire ant, Solenopsis invicta, however, can have severe negative impacts on such systems. We believe that native ants can limit the abundance of *S.* invicta, and that preservation of native ants is important in fire ant management as well as in ecosystem preservation.

We have initiated a comparative study of different sites in east Texas on the ecological conditions that may result in native ants being excluded by, coexisting with, or dominating, S. invicta. We present data on one site studied in some detail, a meadow located in post oak (***Quercus*** stellata) savanna. The meadow occurs in area largely undisturbed by activities that result in significant habitat alteration (**e**.**g**., farming, ranching, logging) for at least 15 to 20 years and has been occupied by S. invicta for at least ten years.

We surveyed the ant fauna in the meadow by searching for nests, by using food baits, and collecting litter samples. A diverse native ant fauna was observed; 17 species in five subfamilies were found (Table 1). At least 10 of these species and S. invicta nest in the meadow, while others have nests at the meadow edge, or venture into the meadow from the surrounding forest (Table 2). Nest mounds of S. invicta are common in the meadow; however, nests of native species are also common (Table 2).

Coexistence of Native Ants and Solenopsis invicta

The post oak savanna of east Texas appears to have persisted for at least several thousand years. Our native ants have presumably evolved to exploit the variety of ant niches within that system. Although we currently have little quantitative data on habitat diversity at the meadow site, it has been largely undisturbed for many years and appears to exhibit substantial native floral and faunal diversity. Native ants may occur in substantial numbers because they are adapted to exploiting the available niches, while *S. invicta* appears adapted primarily to disturbed habitats (Tschinkel 1988).

Ant species in the meadow exhibit a number of niche differences. For example, there are differences in surface activity patterns, nest site locations, foraging behavior, and diet. Such differences are likely important in coexistence among species. However, we also note that the niches of native ants in the meadow and *S. invicta* often overlap to some degree. For example, a number of the native species present are predators and/or scavengers on other arthropods, which are an important component of the diet of *S. invicta* (Vinson and Greenberg 1986). Assuming that food is not unlimited, native ants must, to some degree, limit the population size of *S. invicta*.

If habitat is available for native ant species, stable ant communities may occur with a diversity of native ants coexisting with *S. invicta*. When such coexistence occurs, *S. invicta* populations are likely subjected to population regulation by interspecific competition. When native ants are common, this regulation may be substantial. Because of this, we believe that our native ant species are an important tool in the management of *S. invicta*, and perhaps the most important available for management in natural and semi-natural environments.

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Table 1. Ant taxa found in the meadow, September through November 1998

Dorylinae	Myrmicinae
Labidus coecus	*Cyphomyrmex rimosus*
Dolichoderinae	*Cyphomyrmex wheeleri*
Dorymyrmex flavus	*Monomorium minimum*
Forelius pruinosus	*Myrmecina americana*
Formicinae	*Pheidole dentata*
Camponotus sp. 1	*Pheidole metallescens*
Camponotus sp. 2	*Pogonomyrmex barbatus*
Paratrechina sp.*	*Solenopsis invicta*
Ponerinae	*Solenopsis krockowi*
Hypoponera sp.	*Strumigenys* sp.
Leptogenys elongata	

**P. terricola or P. vividula*

Table 2. Frequency of the nests of ant taxa known to occur in the meadow [1]

Solenopsis invicta	*Pogonomyrmex barbatus*	*Monomorium minimum*	*Forelius pruinosus*	*Dorymyrmex flavus*
16	2	30	8	17

[1] We also know that nests of *Solenopsis krockowi*, *Paratrechina* sp. (*P. terricola* or *P. vividula*), *Cyphomyrmex rimosus*, *Cyphomyrmex wheeleri*, *Hypoponera* sp., and (occasionally) *Labidus coecus*, occur in the meadow, but we are so far unable to determine their frequency. *Pheidole metallescens* and (probably) *Strumigenys* sp. nest at the meadow / forest edge, while other species (Table 1) appear to venture into the meadow from the adjacent forest.

Control of Red Imported Fire Ants with Baits Containing Abamectin (Clinch^{m}, Varsity^{m})

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ABSTRACT

Abamectin is the active ingredient contained in the ant baits recently registered under the trade names of clinch^{TM} (agricultural uses), varsity^{TM} (professional turf) and Ascend$^{®}$ (PCO uses). This poster summarizes results from field trials conducted in 1998 to compare the efficacy and longevity of control with clinch^{TM} (varsity^{TM}) 0.011% ant bait compared with currently used baits and contact insecticides. In each trial, clinch^{TM} (varsity^{TM}) provided equal or better control of red imported fire ants than any of the comparison products. clinch^{TM} is registered for use in citrus (bearing and nonbearing), around the farm, and around chicken houses in all states except California. varsity^{TM} is currently registered for use on turf, lawns, landscapes and other noncrop areas.

INTRODUCTION

Abamectin was developed as a fire ant control product by Merck & Co. beginning in the 1980's and was originally sold as Affirm$^{®}$. More recently, it has been extensively sold into the PCO markets by Whitrnire-Microgen as Ascend^{B}, and in 1998, was registered by Novartis Crop Protection for use in citrus orchards under the trade name Clinch^{TM}, and in professional turf markets under the trade name of Varsity^{TM}. Current channels of distribution are summarized in Table 1. Efficacy of this product has been well documented since its first introduction (Figure 1), but comparisons with more recently registered products were lacking.

Application of fire ant bait at the same time as fertilizer provides economy in the cost of application of both products. However, the effects of blending fire ant baits with fertilizer can result in variable levels of control. Therefore, we were interested in determining if Clinch^{TM} /Varsity^{TM} could be applied as a blended product with fertilizer without affecting fire ant control. Based on the prior knowledge of this product and the new introduction of Clinch^{TM} and varsity^{TM} into each respective market segment, the objectives of this study were as follows:

OBJECTIVES

1. Determine efficacy and longevity of control of imported fire ants using Clinch^{TM} / varsity^{TM} compared with current standard products.
2. Compare the efficacy of Clinch^{TM} /Varsity^{TM} against imported fire ants when applied in combination with fertilizer or alone.

MATERIAL AND METHODS

1998 Studies. Three efficacy studies were established in pasture (MS) and Citrus (FL) during 1998 with Clinch™ 0.011% fire ant bait. Plot size ranged from 0.1 - 15 acres. All trials were replicated 3 - 4 times except for the fertilizer + Clinch™ 0.011% fire ant bait trial where 15 acre plots were treated and evaluations were made from three one-acre subplots. Clinch™ 0.011% fire ant bait was applied as a broadcast application at the rate of one pound of product per acre in all trials and other insecticides were applied at labeled rates. Fire ant populations in all trials were evaluated before treatment and at 4 to 6 week intervals after treatment. Efficacy evaluations consisted of the number of active mounds per plot and the population index.

RESULTS

Efficacy Comparisons. Data gathered before 1998 are summarized in Figure 1. Averaged over twelve trials, Clinch™ 0.011% fire ant bait consistently provided rapid and long lasting control of fire ants. Compared with Amdro®, control with Clinch ™ was equal to or better through 38 weeks. In a 1998 trial conducted in citrus in Polk Co., FL, Clinch ™ provided better initial control of fire ants at 4 weeks after treatment (WAT) than Lorsban, and consistent control was maintained through the 20 week duration of the trial. In a trial conducted in 1998 in Harrison Co., MS, Clinch™ 0.011% fire ant bait applied at 1 lb prod./acre provided better control than Spinosad applied at 1.5 lb prod./acre, and equivalent control to Amdro® and Fipronil applied at 1.5 lb prod./acre from 6-30 weeks after treatment.

Mixture with Fertilizer. A study was conducted in 1998 in Indian River County, FL to determine if the efficacy of Clinch ™ fire ant bait was affected when applied in conjunction with fertilizer. Control of fire ants in plots treated with the Clinch ™ + fertilizer mixture was equal to that obtained in plots treated with Clinch ™ alone. Therefore, these preliminary data suggest that the efficacy of Clinch™ 0.011% fire ant bait was not affected by mixing with fertilizer.

SUMMARY

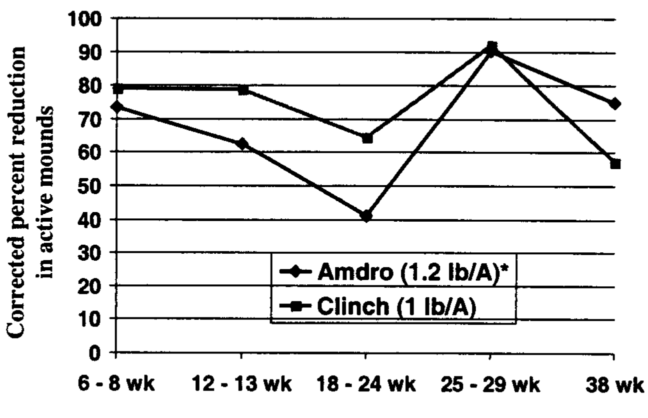
- Clinch™ 0.011% fire ant bait is the lowest use rate product presently registered for control of fire ants, requiring only 50mg of active ingredient per acre.
- Data from 1998 trials indicates that an application of Clinch™ 0.011% fire ant bait in conjunction with fertilizer was as efficacious as Clinch™ 0.011% fire ant bait applied alone.
- 1998 data indicates that Clinch™ /Varsity™ 0.011% fire ant bait provides rapid and long lasting control of fire ants.

- Clinch™ 0.011% fire ant bait is currently registered for use in citrus (bearing and nonbearing), around the farm, and around chicken houses in all states except California.
- Varsity™ 0.011% fire ant bait is currently registered for use on turf, lawns, landscapes and other noncrop areas, and is available through distribution by Lesco.

Table 1. Abamectin Fire Ant Bait Marketing Channels

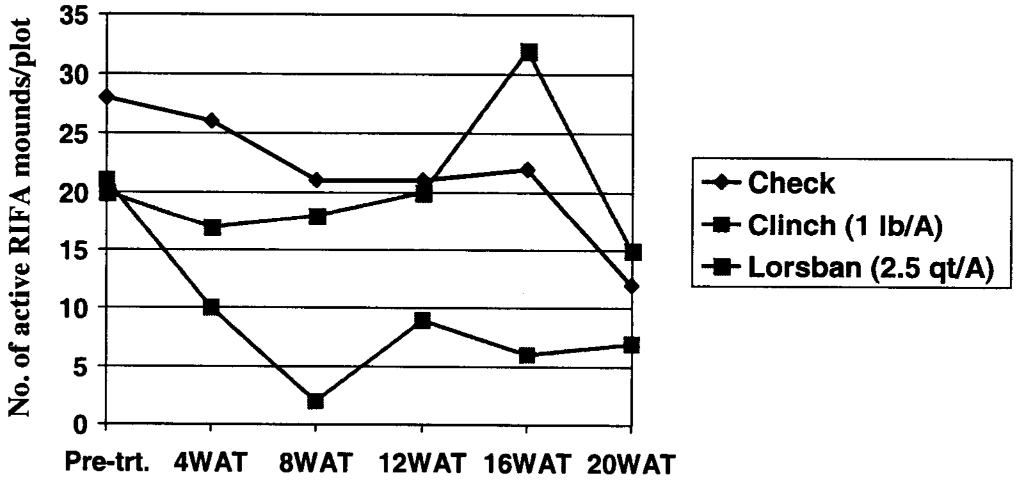
Market Sector	Product	Company	Comments
Turf (professional)	VARSITY	Novartis/ Lesco	Available 1999
Agricultural	CLINCH	Novartis	Bearing citrus
PCO	ASCEND	Whitmire MicroGen	PCO Use
Consumer	RAID fire ant bait	S. C. Johnson	OTC, Mass Markets

Figure 1. Control of Red Imported Fire Ants with Clinch™ 0.011% Fire Ant Bait and Amdro® averaged over twelve trials



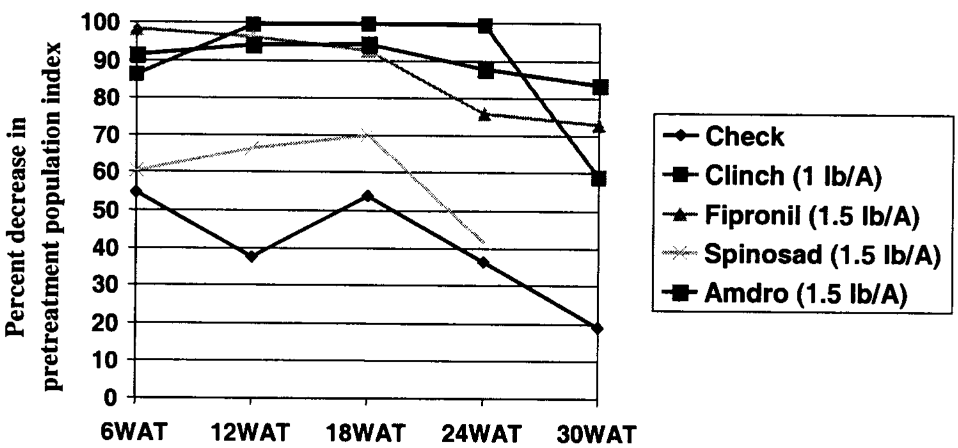
*Amdro was applied at rates ranging from 1.0 to 1.5 lbs prod./A in the twelve trials used in this summary. The average rate was 1.2 lb prod./A

Figure 2. Red Imported Fire Ant Control in Bearing Citrus, Polk CO., FL (R. Patterson, 1998)



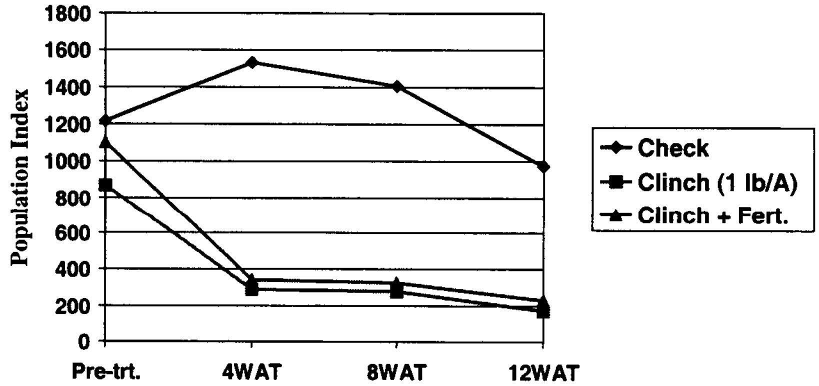
Applications made to 0.1 acre plots.
Lorsban 4ECapplied through the irrigation system.

Figure 3. Control of Red Imported Fire Ants in pasture, Harrison CO., MS 1998 (H. Collins, USDA)



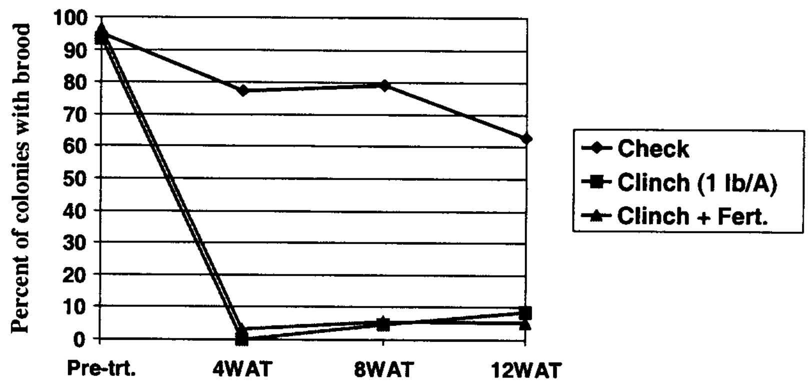
Applications made 12 & 13 May 1998 to 1 acre plots.
Amdro (0.73% hydramethylnon, American Cyanamid), Fipronil (0.00015% Rhone-PoulencAg. Co.), and Spinosad (0.015%, spinosad, Dow Agrosciences).

Figure 4. Control of Red Imported Fire Ants in citrus with Clinch™ 0.011% Fire Ant Bait and the effect of blending with fertilizer, Indian River CO., FL 1998



Treatments were applied to 15 acre plots.
The Clinch + Fertilizer treatment contained: 23.5lb ammonium nitrate, 31 lbs sulfate of ammonia 6.5 lb diammonium phosphate, 8 lb NY sludge, 24 lb pot ash, 24 lb super Mg, 45 lb phosphoric rock shavings, and 1 lb Clinch / acre.

Figure 5. Control of Red Imported Fire Ants in citrus with Clinch™ 0.011% Fire Ant Bait and the effect of blending with fertilizer, Indian River CO., FL 1998



Treatments were applied to 15 acre plots.
The Clinch + Fertilizer treatment contained: 23.5lb ammonium nitrate, 31lbs sulfate of ammonia 6.5lb diammonium phosphate, 8lb NY sludge, 24lb pot ash, 24lb super Mg, 45lb phosphoric rock shavings, and 1lb Clinch / acre.

Is fire ant scouting behavior influenced by nutritional history and abiotic factors?

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Understanding how the fire ant scouting network alters in response to variation in the environment will contribute to our ability to control this invader. In controlled greenhouse conditions we made observations of the foraging network of polygyne colonies under two different nutritional history regimes: recently fed and food deprived. We found that the network of foragers approximately doubles over a relatively short period of food deprivation (38-50) hours. During food deprived periods scouting ants were also more likely to be active at high air and surface temperatures.

Video recordings of their foraging activity show a previously unknown recruitment behavior. We hypothesize that this behavior - reported here as spurious recruitment - may in part help the network of foragers to quickly react to nutrition shortages inside the colony. Normally, recruitment is initiated when a scout finds a resource in her foraging area and returns to the colony laying a chemical trail that is followed outward by reserves from the nest (Wilson 1962). The recruitment we observed was unusual in that 1) no resources were available for collection by the scouts over the time periods taped, 2) review of the video tape prior to the recruitment events could find no identifiable trail-laying worker initiating recruitment from the direction opposite of where the trail eventually formed, and 3) the events were of a relatively short duration. Our data show that as the period of time since last feeding increases, spurious recruitment trails increase in frequency and number of trail followers.

We hypothesize that spurious recruitment is an adaptation for responding to resource shortages in the colony. As the foragers out afield do not report back to the colony (because they have not found any resource), reserves inside the colony may begin to respond to the lack of nutrients by promoting themselves to forager status earlier than they may have otherwise. As these newly promoted foragers leave the colony, small numbers of reserves are apparently attracted to these 'leaders.' Once in the foraging territory these spurious recruitment groups eventually disband, leaving the recruited reserves out to forage. This hypothesis may help explain how fire ant colonies increase the number of scouts out in their foraging areas so quickly, when deprived of food over relatively short time periods.

References

Wilson, E. O. 1962. Chemical communication among workers of the fire ant Solenopsis ***saevissima*** (Fr. Smith) 1: The organization of mass-foraging; 2: An information analysis of the odour trail; 3: The experimental induction of social responses. Anim. Behav. 10: 134-147, 148-158, 159-164.

Effects of Juvenile Hormone and Precocene Treatments on Dealation of *Solenopsis invicta* Female Alates

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Topical treatments of JH III induced wing casting in sexually mature *Solenopsis invicta* female alates. One hundred percent dealation occurred within 24hr of applying lng of JH III in lul of acetone, while longer time periods were observed for smaller doses. Topical applications of precocene I and II (100ug/ul of acetone) prevented dealation in disinhibited alates. Because precocene destroys the corpora allata, the source of JH, these results strongly suggest that JH is the natural inducer of wing casting in *S. invicta.*

Similar rates of dealation were observed in sexually immature (newly-eclosed) and mature (7-day- and 14-day-old) *S. invicta* female alates that were released from queen pheromonal control. One hundred percent dealation occurred within four days of disinhibition. The results of this study suggest that the quantities of JH produced in *S. invicta* do not increase with age; hence, once freed from pheromonal control, sexually mature female alates do not shed their wings more readily than sexually immature individuals. These findings also suggest that the corpora allata of alates become active within four days of pheromonal liberation, regardless of sexual maturity.

The area (length x width) of the corpora allata was measured for sexually mature S. *invicta* female alates and sexually mature queens and unmated dealates. Results indicate that there are no differences in the sizes of the glands among these groups. Though no evidence in the literature correlates the size of the corpora allata and the production of JH, measurements obtained from this study provide additional data to our limited knowledge of the corpora allata in ***S** invicta*

EVALUATION OF CANDIDATE QUARANTINE TREATMENTS FOR GRASS SOD

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ABSTRACT:

In 1998, we conducted a field trial at Slidell, LA airport under simulated sod farm conditions. Fipronil was applied at three rates of application while tefluthrin, lambda-cyhalothrin, and bifenthrin were applied at a single rate of application. Higher rates of fipronil provided excellent control throughout the trial.

INTRODUCTION:

Federal Quarantine 7CFR 301.81 stipulates that nursery stock, grass sod, and other regulated articles may not be shipped outside the quarantine area unless treated with a USDA approved and EPA registered pesticide. At the current time, the only products available for this use are Dursban® 50WN (Dow AgroSciences), and Dursban® TNP (United Horticultural Supply). We evaluated four candidate pesticides in 1998.

MATERIALS AND METHODS:

The test site was located at the Slidell Municipal Airport in Slidell, Louisiana. Mowed areas between taxiways and runways simulated conditions that occur in commercial turfgrass. Granular products were applied broadcast to test plots using a Herd® GT-77 spreader (Herd Seeder Co., Logansport, IN) on a farm tractor on June 3-4, 1998. There were 3 replicates per treatment. Products, producers, and rates of application are listed below:

Product	% active ingredient	Producer	Rate of application (lbs/acre)
Fipronil	0.05%	Rhone-Poulenc Ag. Co., Raleigh, NC	25.0, 37.5, 50.0
Force	1.5% tefluthrin	Zeneca Ag Products, Wilmington, DE	46.7
Lambda-cyhalothrin	0.1%	Zeneca Ag Products, Wilmington, DE	120
Talstar	0.2% bifenthrin	FMC Corp., Philadelphia, PA	100

A ¼ acre circular efficacy plot was established in the center of each 1.0 acre test plot (Figure 1). Prior to and at 2, 4, and 6 weeks after treatment, and at 6 week intervals thereafter, IFA populations in each efficacy plot were evaluated using the population index system developed by Harlen et al. (1981) and revised by Lofgren and Williams (1982). Using this data, both colony mortality and decrease in pre-treatment population index were calculated. Data were statistically analyzed using analysis of variance and means separated using Tukey's test (P=0.05) for each post-treatment interval.

RESULTS:

Treatments were applied on June 3-4, 1998 with air temperatures between 87-94°F and soil temperatures between 80-82°F. Efficacy results are shown in Tables 1 and 2. At 2 weeks after treatment, Talstar and the two high rates of fipronil provided the greatest control of IFA. By 4 weeks, all treatments, except lambda-cyhalothrin reduced pretreatment population indices by >85%, and all except lambda-cyhalothrin and the lowest fipronil rate, reduced colony numbers by >70%. The 50.0 lb/acre rate of fipronil provided 100% control at 4 weeks. At 6 weeks after treatment, all fipronil rates and the Force treatment were still significantly better than the check; the low fipronil rate and Force provided >80% reduction in population indices, and the two higher fipronil rates provided >95% reduction in population indices.

At 12 weeks after treatment, all fipronil rates provided 100% control of IFA. All other products provided 60-75% control of IFA. At 18 weeks after treatment, the 2 lower fipronil rates provided 100% control of IFA; one plot in the high fipronil rate had one large reproductive colony, which probably migrated into the test plot from the untreated surrounding area. All other treatments had reproductively viable colonies infesting them, and the Talstar and lambda-cyhalothrin plots were not evaluated after this time.

At 24 weeks after treatment, the two higher fipronil rates were at 100% mortality; the one mound found on a high rate plot at 18 weeks had either moved out of the plot or succumbed to the treatment. Two of the plots of the lowest fipronil rate (25 lb/acre) had reproductively viable colonies (1 and 2 per plot) on them, indicating possible reinfestation. The Force plots were all reinfested with reproductively viable colonies, and were not evaluated after this time.

Fipronil rates of 37.5 and 50 lb/acre continue to provide excellent control of IFA through 32 weeks after treatment. Plots treated with the low rate continue to have a few (2 per plot) reproductively viable colonies present.

All fipronil treatments will continue to be evaluated until general reinfestation is noted; although the time interval between evaluations were lengthen to 8 weeks during the winter months.

These results clearly demonstrate the potential of fipronil as a quarantine treatment for commercial grass sod.

DISCUSSION:

Talstar 0.2G, at 100 lbs/acre (0.2 lb AI/acre), provided extremely fast knockdown of IFA (>88% mortality at 2 weeks after treatment), but did not provide adequate residual control, as evidenced by the rapid reinfestation by either movement into the treated area, or possibly rejuvenation of treated colonies. Lambda-cyhalothrin at the rate used (120 lbs/acre or 0.12 lb AI/acre) never provided better than 75% control of IFA, and at all evaluation periods there were reproductively viable colonies present. Force at 46.7 lbs/acre (0.7 lb AI/acre) performed a little better numerically, providing 70-80% control of IFA.

In general, the higher the rate of application with fipronil, the faster the control of IFA. The 2 higher rates provided >84% control of IFA by 4 weeks after treatment, >91% after 6 weeks, and by 12 weeks after treatment, all rates provided 100% control of IFA. The lower rate achieved the same control (100%) at 12 weeks, but in the preceding weeks was numerically inferior to the higher rates of application. The lowest rate has shown good control of IFA through 18 weeks, while the 2 higher rates have provided excellent control through 32 weeks.

<u>References Cited</u>:

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Lofgren, C.S. & D.F. Williams. 1982. Avermectin B_1a, a highly potent inhibitor of reproduction by queens of the red imported fire ant. J. Econ. Entomol. 75: 798-803.

Figure 1. Plot design. One acre plot with ¼ acre efficacy plot in center.

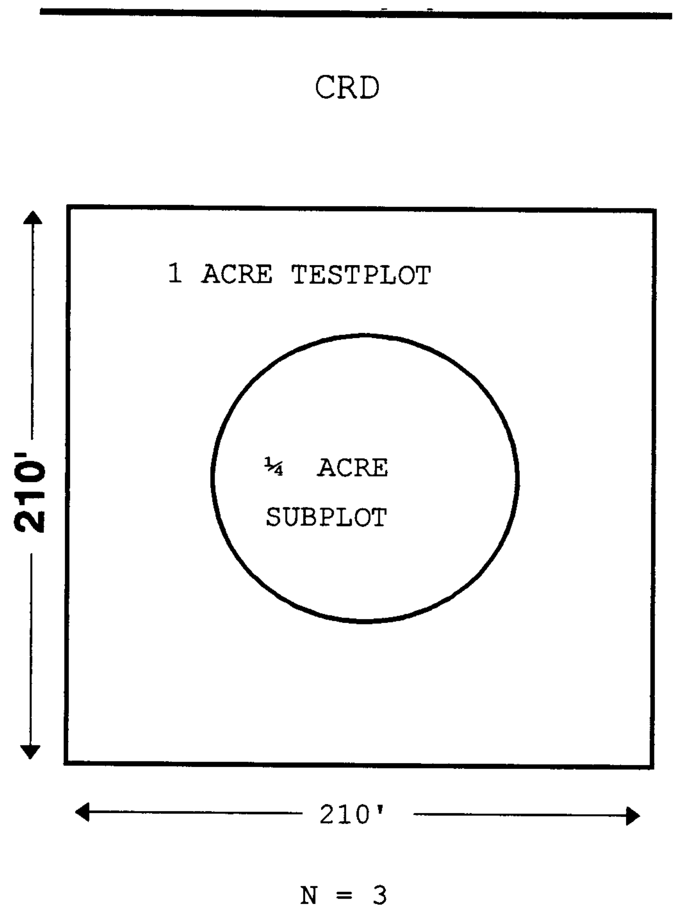

Table 1. Efficacy of various granular insecticides applied broadcast to grass sod: change in pretreatment population indices. Slidell Airport, LA; June 3-4, 1998.

Treatment	Rate of Applic. (lb/acre)	Mean pretreat population index/acre*	% change in pretreatment population indices at indicated wks PT**						
			2 wks	4 wks	6 wks	12 wks	18 wks***	24 wks	32 wks
Fipronil	25.0	526.8	-43.0abc	-85.1a	-85.9a	-100.0a	-100.0a	-85.1ab	-86.3a
Fipronil	37.5	313.2	-91.1a	-89.7a	-99.3a	-100.0a	-100.0a	-100.0a	-100.0a
Fipronil	50.0	404.0	-76.9a	-100.0a	-95.2a	-100.0a	-90.5a	-100.0a	-100.0a
Force	46.7	440.0	-70.5ab	-89.6a	-80.2a	-59.2ab	-75.7a	-23.9c	--
Lambda-cyhalothrin	120.0	366.8	-16.2c	-64.9ab	-74.3ab	-61.6ab	-66.9a	--	--
Talstar	100.0	312.0	-94.7a	-88.7a	-63.9ab	-75.6a	-20.3a	--	--
Check	--	620.0	-19.4bc	-34.0b	-30.1b	-28.8b	-48.1a	-36.8bc	-37.3b

* Mean of 3 replicates.

** Means within a column followed by the same letter are not significantly different (Tukey's test, P=0.05).

*** 18 wk count made on 10/9/98 after Hurricane Earl (9/1-9/3), T.S. Frances (9/10-9/13), T.S. Hermine (9/17-9/22), and Hurricane Georges (9/26-9/28) impacted the count area with tremendous rainfall amounts. Total rainfall for the 5 weeks proceeding this count was approximately 32 inches.

Table 2. Efficacy of various granular insecticides applied broadcast to grass sod: decrease in pretreatment colony numbers. Slidell Airport, LA; June 3-4, 1998.

Treatment	Rate of Applic (lb/acre)	Mean no. pretreat colonies/ acre*	% decrease in no. of pretreatment colonies at indicated wks PT*						
			2 wks	4 wks	6 wks	12 wks	18 wks***	24 wks	32 wks
Fipronil	25.0	30.8	41.1bc	56.1ab	72.3ab	100.0a	100.0a	83.9ab	81.1a
Fipronil	37.5	24.0	88.6a	83.8ab	95.2a	95.2a	100.0a	100.0a	100.0a
Fipronil	50.0	25.2	68.3ab	100.0a	91.7a	100.0a	93.3ab	100.0a	100.0a
Force	46.7	29.2	63.9ab	79.3ab	74.5ab	63.4ab	76.3ab	34.8c	--
Lambda-cyhalothrin	120.0	24.0	22.9c	35.7b	73.0ab	56.8ab	67.1ab	--	--
Talstar	100.0	21.2	88.6a	70.0ab	53.8ab	75.2ab	28.6b	--	--
Check	--	40.0	19.7c	35.6b	31.4b	27.8b	40.3ab	41.7bc	30.6b

* Mean of 3 replicates.

** Means within a column followed by the same letter are not significantly different (Tukey's test, P=0.05).

*** 18 wk count made on 10/9/98 after Hurricane Earl (9/1-9/3), T.S. Frances (9/10-9/13), T.S. Hermine (9/17-9/22), and Hurricane Georges (9/26-9/28) impacted the count area with tremendous rainfall amounts. Total rainfall for the 5 weeks proceeding this count was approximately 32 inches.

[14C] Fipronil Flow in Laboratory-Reared Colonies of the Red Imported Fire Ant, Solenposis invicta Buren

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Workers feeding on 10 ppm [14C] Fipronil in corn oil, quite rapidly, distributed this compound to nestmates, brood and reproductives via trophallaxis. Medium workers ingested about 2.3 ng, whereas a major worker consumed about 17 ng. [14C] Fipronil was detected in larvae by 24 hr. Dead queens were found after about a week and contained about 0.3 ng, individual dead workers contained about 0.14 ng and live, asymptomatic workers 0.03 ng (equivalent to background).

INFLUENCE OF FIRE ANT COLONY DENSITY ON FORAGING ACTIVITY OF FIRE ANTS AND SMALL MAMMALS

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Abstract: We are further exploring the influence of red imported fire ant (Solenopsis invicta) colony density on foraging activity of small mammals. We began the study in June 1998 on an ungrazed 60 x 150 m pasture located in the Post Oak savanna 15 km south of College Station, TX. We divided the site into 3 adjacent areas and established parallel small mammal trap lines 6 m apart, each consisting of trap stations 3.3 m apart. Each area was flagged to establish a 2.5 x 2.5 m grid for use in ant census/treatments. We trapped small mammals each month for 5 consecutive nights using one 7.5 x 7.5 x 20 cm Sherman live trap per trap station. Species captured to date include: cotton rat (Sigmodon hispidus), pygmy mouse (B. *taylori*), white-footed mouse (Peromyscus leucopus), and fulvous harvest mouse (Reithrodontomys *fulvescens*). We quantified ant activity during census/treatment by counting the number of ants of each species recruited to census stations in each area in which we placed a vial (1.5 cm diameter x 5 cm) containing 2 pellets of cat food. Species of ants collected include: S. *invicta*, Paratrichina sp. (either *terricola* or *vividula*), Monomorium minimum, and S. *molesta*. One third of the site, Area 1 (Control), contained naturally occurring densities of S. *invicta*. We treated Area 2 (Fire Ant Removal) during each census/treatment procedure from July 1998 through September 1998 with an ant-toxic bait (Amdro®, active ingredient: hydramethylnon 0.73%) to reduce density of S. *invicta*. Area 3 (Native Ant Removal/Fire Ant Addition) was treated during the same period with Amdro® to reduce density of native ants. In October 1998, 10 colonies of fire ants were added, using specially designed

containers, to Area 3 (Native Ant Removal/Fire Ant Addition) to further increase fire ant density.

To date our results reflect the seasonal variation and species-specific nature of small mammal responses to *S. invicta* which have been suggested by earlier studies, although the specific ecological processes that generate observed differences remain elusive. This is especially evident in Area 3 where data interpretation is made difficult because of habitat differences from the other 2 areas and the delay of the fire ant colony addition while a successful procedure was being developed.

Amdro® appears to markedly reduce foraging activity of both fire ants and native ants.

Landscape Predictors of Fire Ant Occurrence and Endangered Species Spatial Risk Assessment

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Fire ants negatively impact a number of vertebrate and invertebrate species. Assessment of impacts on individual species would be time consuming and costly. Instead, we are conducting a state-wide risk assessment of threatened and endangered species to fire ant impacts by investigating the spatial co-occurrence of fire ants and endangered species. We are also investigating landscape-level predictors of fire ant distribution at the state level. The objectives are 1), To develop a model that predicts which native threatened and endangered species are at risk from fire ants, and 2), To develop models of fire ant distribution and habitat use in terms of landscape elements (patch size, fragmentation, habitat type, etc). Additionally, the data from this research will be provided to two other projects. One, a state-wide GIS coverage of ant diversity (the SC Gap Analysis Project), the first in a national effort to map ant diversity. Second, this project also complements an investigation of scale effects on the prediction of fire ant populations.

Fire ants will be sampled throughout the state of South Carolina. Sampling will be stratified by ecoregion and by landcover. Data from samples will then be used in conjunction with landscape elements to construct a logistic regression model that identifies significant landscape element predictors of fire ant patch occupancy and to create a predictive model applicable across the state. Risk assessment will be accomplished by overlaying the results of the predictive model of fire ant distribution with the models of rare and endangered vertebrates and invertebrates developed by the South Carolina Gap Analysis Program.

Relation between temperature changes and movement within polygynous colonies of the red imported fire ant

By

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Abstract

Movement of queens and brood by workers within polygynous colonies was studied in relation to the change in nest temperature. The study was conducted using two nest areas in which the temperature could be varied independently (48°C and 24°C). These nests were joined together by a connecting tube and the fire ant colony was introduced into one of these nest areas. Prior to the experiment, the worker preferences for each queen were ranked. After they were acclimatized to the nest, they were induced to move by changing the temperature. The behavior of the workers and the queens during colony movement was observed. The results showed that the most preferred queen is manipulated by the workers but reached the cool environment after a significant elapse of time compared to the least preferred queen.

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February 22,1999

Tast-E-Bait™

A NEW FIRE ANT BAIT
(Patent Pending)

Tast-E-Baitm Technical Data;

Mesh Size	-10+40
Moisture Content	less than 7%
Loose Bulk Density	29 lbs./cu.ft.±2 lbs./cu.ft.
Particles Per Pound	1,296,000
pH	6.7
Soybean Oil Capacity	30%±2%
IFA Acceptance Ratio	1 to 1.228

Contents:

Tast-E-Bait™ is a processed by-product of the food industry where all ingredients were FDA approved. The ingredients were designed for human consumption and no toxic hazards are evident. It is biodegradable.

BACKGROUND

David I. B. Vander Hooven has over 50 years experience in processing by-products, primarily corncobs, for many uses. He pioneered corncob carriers for IFA Baits (Mirex and others) in the late 1960s and continues to work closely with both the government and private sectors to keep abreast of IFA activities.

This latest bait, Tast-E-Bait™, an invention of Dave's is, generating much interest in the IFA Market since its discovery this past December and your inquiries, comments and suggestions are welcome.

The raw material, a food industry by-product, is readily available in large quantities. Actual production of Tast-E-Bait™ is foreseen as taking various sources of raw materials and blending them together under rigid standards to produce a uniform bait for all AIs in not only the IFA Market, but other pesticide baits as well.

It is well known that in many instances formulations involving the use of 20-30% soybean oil with the AI in the oil causes caking on the walls of mixers. This caking causes assay problems in the finished products. Tast-E-Bait™ comes with an inherent 27% soybean oil content from its ingredients. It is necessary to add only 3% SBO with the AI at the time of formulating or it can be delivered with a total of 30% SBO in it. You can, at that point, add the AI dissolved in a solvent if you wish.

Adding AI dissolved in a solvent such as acetone to a bait that already contains 30% SBO should simplify the formulating process. Initial studies show no affect on the attractiveness and the acceptability of Tast-E-Bait™ after the application and evaporation of acetone on it.

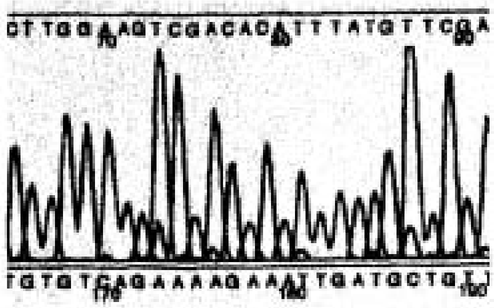
The large number of particles per pound in Tast-E-Bait™ is intended to give greater and more uniform coverage in the field for urban and rural areas alike.

The acceptability studies of Tast-E-Bait™ that were performed in several replicas at the USDA in Gulfport, Mississippi in February were excellent. The mean acceptance ratio (grams of candidate bait removed divided by grams of standard bait, which in this case was pre-gelled corn @ 30% SBO) resulted with a ratio of 1 to 1.228 for Tast-E-Bait™ when loaded to 30% SBO and, in one study an acceptance ratio of 0.65 when no SBO was added.

Calibration and distribution studies of Tast-E-Bait™ will take place at the USDA in Gulfport in March. It is anticipated that efficacy studies will be completed by late June.

Production of Tast-E-Bait™ can begin shortly after. Your inquiries are welcome.

..through use of techniques in molecular biology



Partial sequence of the gene that codes for cytochrome P450 in fire ants.

..and through an understanding offire ant ecology.

Pitfall traps are one technique used in studying how fire ants and their control impact non-target organisms.

The Alabama Department of Agriculture and Industries funds the Alabama Eire ant management program. Entomologists at Auburn University conduct the projects, with the cooperation of the Alabama Cooperative Extension System and the USDA Agricultural Research Service. The following projects are ongoing in 1999:

Evaluation of integratedpest management methods for red importedjire ants in Alabama. Kathy Flanders, Patricia Cobb, and Lawrence (Fudd) Graham.

Flight energetics and desiccation tolerance of red imported fire ant alates. Arthur Appel.

Characterization of arthropod communities in fire ant managed areas in Alabama. Gnry Mullen.

Role of cytochrome P450 monooxygenases in red importedjire nnts. Nannan Liu.

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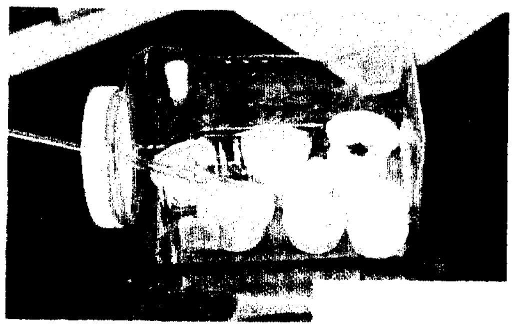
Fireants/fireant.html

The Alabama Fire Ant Management Project

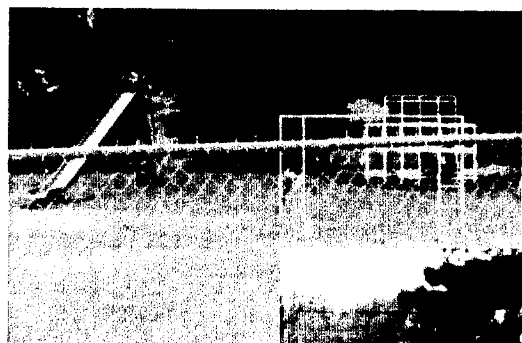
Making fire ants easier to live with…

by releasing biological control agents…



The decapitating fly, *Pseudacteon tricuspis*, provided by the USDA-ARS lab in Florida, has been released in Talladega County.

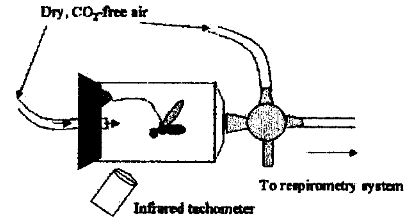
…by devising targeted-bait strategies that minimize cost and maximize fire ant control…



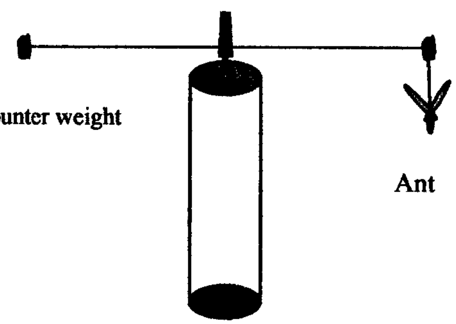
The Tuscaloosa school fire ant demonstration site.

…through an understanding of the physiology of fire ant flight…

Carbon Dioxide Production
And
Wing Beat Frequency



Circular Flight Mill



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